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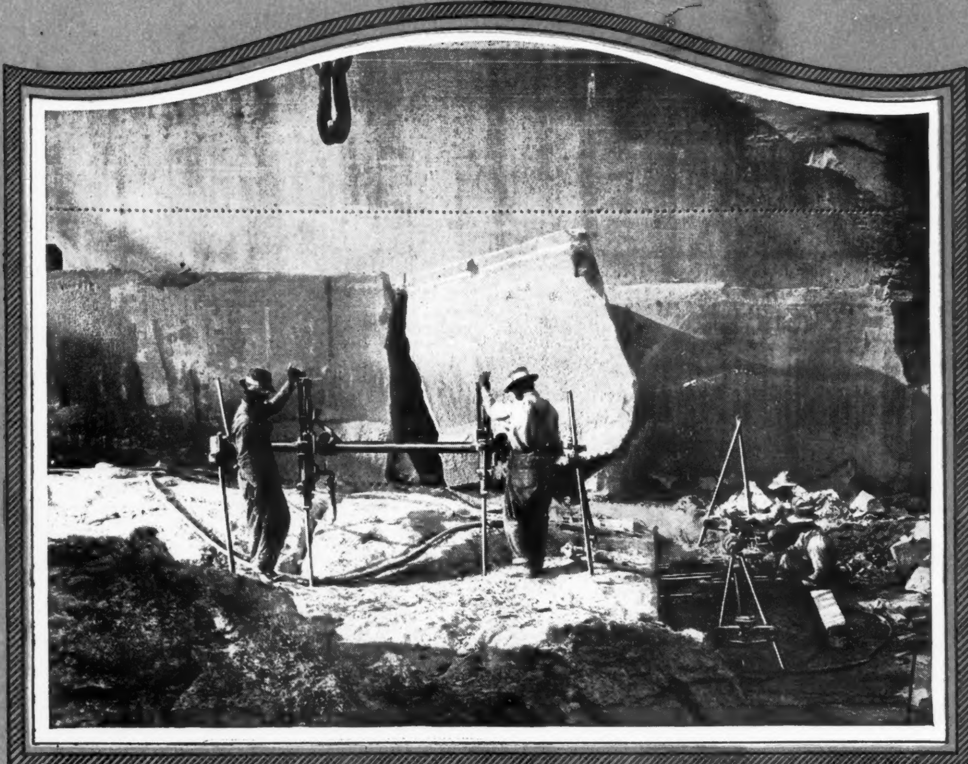
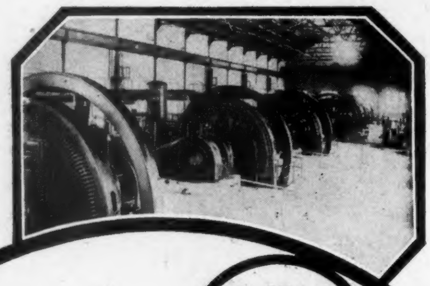
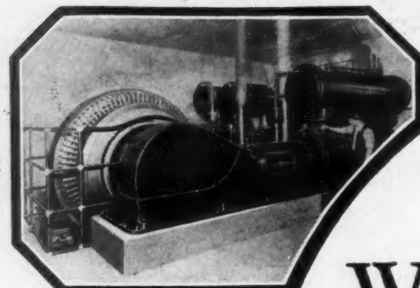


THE MODERN HAMMER DRILL IS NOW USED VERY EXTENSIVELY IN ALL KIND OF QUARRIES

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)

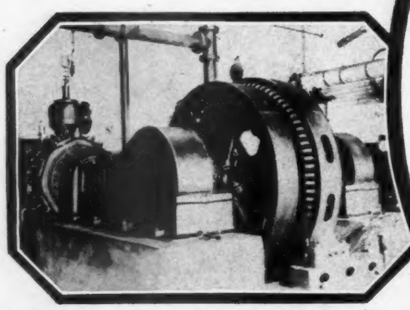


1200hp. Westinghouse Synchronous Motors driving Norberg Compressors.

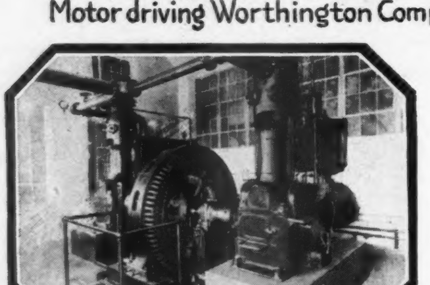


600hp., 200rpm. Westinghouse Motor driving Chicago Pneumatic Tool Compressor.

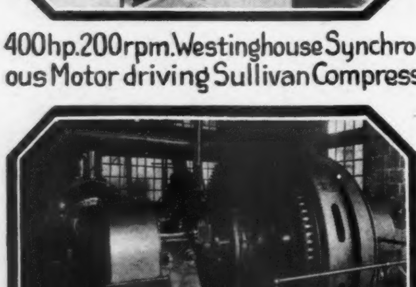
Westinghouse Builds Synchronous Motors for Every Size and Type of Compressor



200hp. 225rpm. Westinghouse Synchronous Motor driving Worthington Compressor.



400hp. 200rpm. Westinghouse Synchronous Motor driving Sullivan Compressor



187hp. 150rpm. Westinghouse Synchronous Motor driving Ingersol-Rand Compressor

The Logical Drive

There are many reasons for the superiority of synchronous motors on compressor drive. One is the low cost of its operation; a second is the compactness of it; a third is its high efficiency at ½, ¾ or full load and its ability to operate for long periods with little or no attention.

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OCTOBER, 1922

Robbing Railroading of Some of Its Hazards

Automatic Train-Control Devices Will Apply the Air Brakes Whenever an Engineer Fails to Heed the Warning Wayside Signals

By ROBERT G. SKERRETT

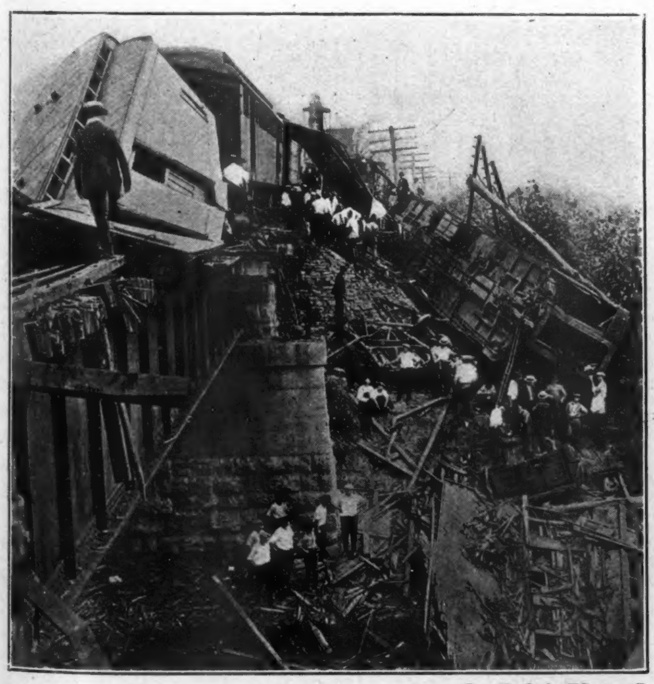
"FAILURE OF AN ENGINEER to heed a block signal caused the rear-end collision on the Missouri Pacific Railroad here last night in which 38 persons were killed and about 137 injured." So a recent news account summed up the disastrous consequences of momentary inattention on the part of the man at the throttle of an onrushing passenger train.

Fortunately, the foregoing disaster was one of exceptional scope, but, even so, human fallibility exacts a grim toll annually in the operation of the quarter of a million and more miles of our railroads. The Government authorities that have general supervision over these lines are convinced that it is possible to check the hazards that cost us so dearly in life, bodily injury, and destruction of property.

Between July 1, 1911, and March 31, 1922, there were 80 collisions which caused the death of 416 persons, the injury of 1,837 people, and property loss, not including damage to lading, amounting to many millions of dollars. Those accidents occurred in railway territory equipped with automatic block-signals, and were officially declared to be due directly or indirectly to the failure of the engineman to observe or to be governed by the signal indications.

While it may never be practicable to realize an efficiency of 100 per cent. in the safe operation of our far-flung network of trunk lines, still the Interstate Commerce Commission is satisfied that there is room for considerable improvement; and this Federal body has initiated steps looking to the greater security of passengers and of freight while in transit. To this end, after nearly fifteen years of study, and with due regard to the state of the art, the Commission has recently ordered 49 of the principal railroads of the country to install automatic train-control devices on 5,000 miles of their lines by the first of January, 1925.

Not without reason, the railroads have long opposed the adoption of apparatus of this sort, and they have advanced good arguments in support of their stand. In the main, they have contended that the systems offered were in an experimental stage; that many of them tended to hamper the man at the throttle in the discharge of his duties; that the devices were not rugged enough to meet service requirements; and, finally, that their use would add dis-



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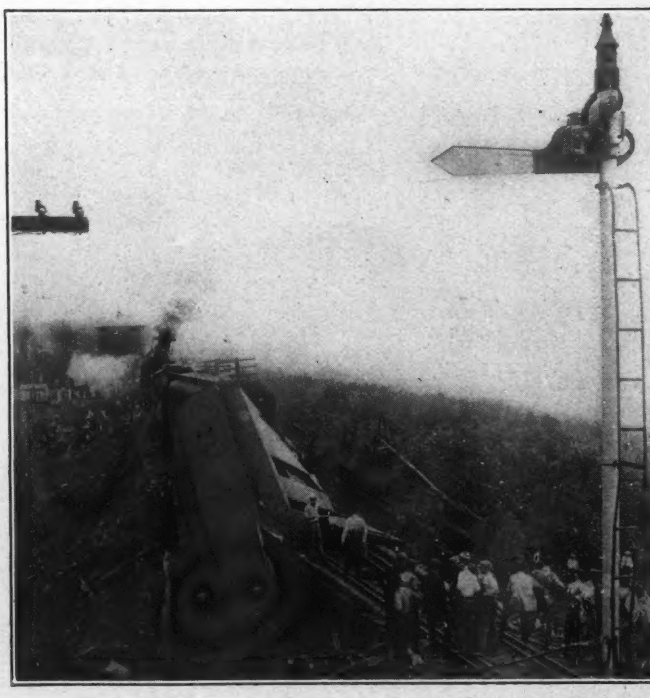
It was the engineer's failure to heed the wayside signal which led to this wreck and cost the lives of 38 persons.



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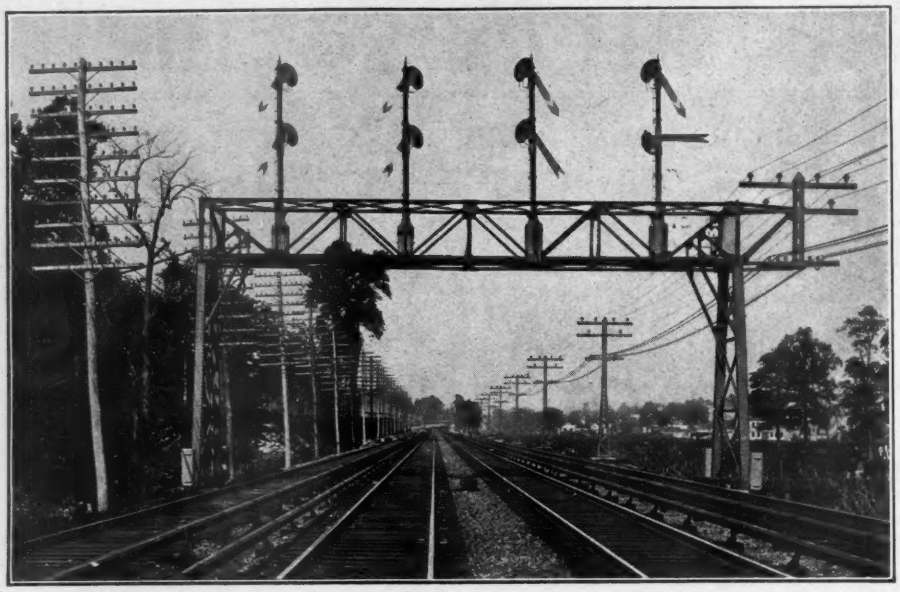
The scene of the disastrous rear-end collision at Sulphur Springs, Mo. The semaphore at the right is set at "stop" or "danger."



A typical signal bridge spanning a four-track roadway. It is by the positions of the semaphores during the daytime and by the colors of the signal lights at night that the engineers are notified as to the condition of the sections ahead.

proportionately to the expense of up-keep of the sections and of the rolling stock so equipped. To clinch their position, the lines have pointed out that wayside signals should suffice to warn the engineer; and, not without warrant, they have extolled especially the reliability of those automatic block-signal installations which function as though directed by an ever-wakeful mind.

But the proponents of automatic train-control apparatus have countered: "Granting all that has been said in favor of automatic block-signals, why haven't they prevented railroad collisions?" And, in answer to their own question they say: "Because, in order to be effective, the signals must be seen, must be understood, and must be obeyed by the engineman." Wayside signals serve merely to indicate traffic conditions, and they fail of their purpose if the man at the throttle, for one reason or another, does not heed them. The state of the atmosphere may seriously affect the visibility of the cautioning semaphore or light. Even when seen, the signal may not always be read aright; and it is no uncommon thing for an engineer to take a chance and to run past a danger signal, confident that he can bring his train to a halt soon enough to avoid an accident.

The average passenger aboard any of the noted fast expresses little realizes how much his safety depends upon the engineer and the sureness with which he reads the warnings of the wayside signals—particularly when darkness, fog, snow, or smoke hamper clarity of vision. Theoretically, both the engineman and his fireman are supposed to watch the semaphores and lights; but, as a matter of fact, sometimes for hours at a stretch, the fireman toils ceaselessly feeding coal into the roaring furnace so that the locomotive may have the needful energy to race along with its attached cars at a rate of 50, 60 or 70 miles an hour. The responsibility of observation then rests entirely upon the engineer.

This situation is disquieting enough in itself, but matters are commonly more complex than this in the case of many of our long-distance "specials." These trains are frequently run in sections—really they are a group of trains which follow one another at brief intervals and at the same speed. Unless all of them move in harmony, and to do this the wayside signals must be obeyed implicitly, a catastrophe might easily result. That smash-ups of this kind are exceptional is the best evidence of the vigilance of the men to whom the guidance of these trains is entrusted; but the tax upon their nerves is, nevertheless, a heavy one.

In direct proportion as the density of traffic increases upon the lines centering upon a large city or at any other railroad focal point, it is a matter of both vital and economic concern to keep inbound and outbound trains of all sorts underway and to reduce to a minimum the number of emergency or unscheduled stops. It has been conservatively estimated that the halting and the subsequent resumption of headway of trains of all classes involve an average outlay of fully forty-five cents per train. Therefore, in a district where scores and scores of trains are handled daily, the correct reading of block signals and the proper response to them might effect an annual saving totaling hundreds of thousands of dollars—and this quite apart from the savings through the avoidance of accidents.

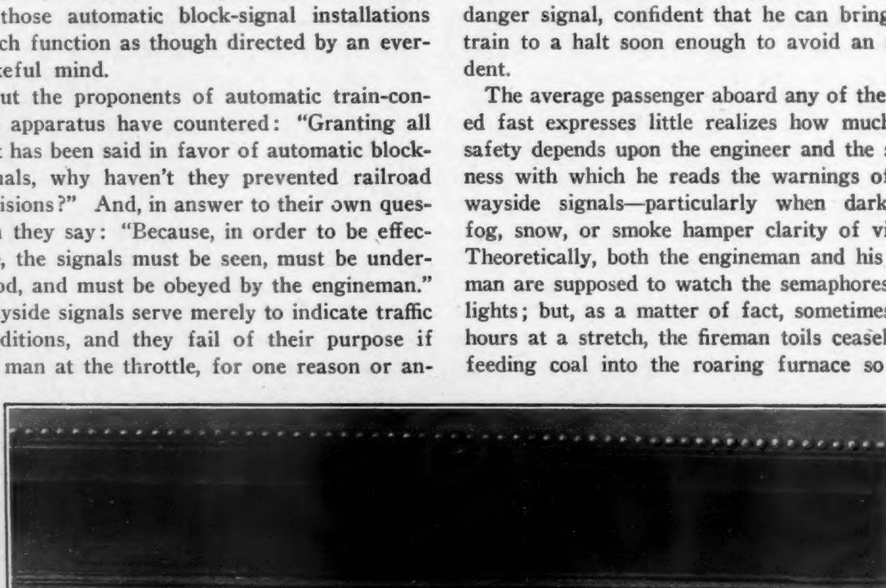
In 1919, the United States Railroad Administration called into being the Automatic Train Control Committee, and that organization agreed upon the following definition of automatic train control: "An installation so arranged that its operation automatically results in either one or the other or both of the following conditions:

"First. The application of the brakes until the train has been brought to a stop.

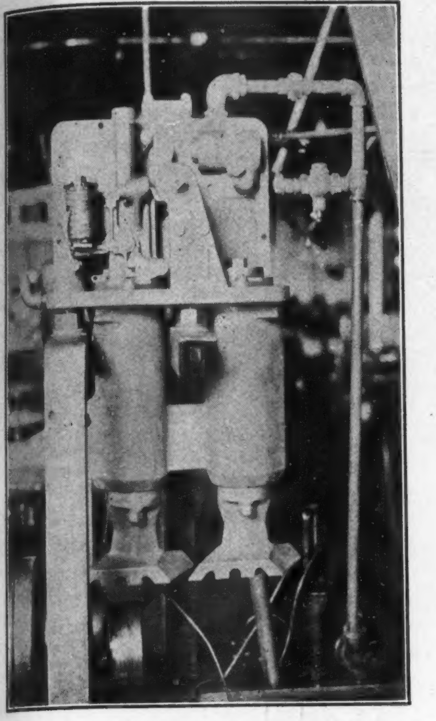
"Second. The application of the brakes when the speed of the train exceeds a prescribed rate and continued until the speed has been reduced to a predetermined rate."

And then, among other things, the Committee specified that any acceptable automatic train-control apparatus should be so constructed that it would operate effectively in connection with existing systems of fixed, block, or interlocking signals; that the device should also be so designed that it would function with certainty under all conditions of speed, weather, wear, oscillation, and shock; and that the working of the equipment should in no wise interfere with the regular application of the brakes by the engineer or tend to impair the efficiency of the air-brake installation.

The foregoing is only an incomplete list of the requisites prescribed by the Committee, and yet the things it calls for are so diversified and exacting that even a layman can realize the task imposed upon the inventive mind. Undismayed, the creative genius of the country has attacked the problem from many angles; and gradually, out of all of these efforts, there has been evolved a number of automatic train-con



Part of the General Railway Signal Company's automatic train-control system. The inductor is the element secured to the ties and the magnetic receiver is the apparatus above, which is attached to the underside of a locomotive's tender.



A close-up of the Webb apparatus with part of the casing removed. The magnet is seen at the left. Only the left-hand shoe lifts the plunger which controls the brake valve. The right-hand shoe merely scrapes the third rail or ramp to clear away ice, snow, mud, etc.

trol systems which are capable of meeting the fundamental requirements in a satisfactory manner. It is not possible in the present article to do more than to describe this notable work in a general way and to summarize the state of the art by dealing with a few of the apparatus which typify the principal classes into which these inventions are grouped for technical reasons.

The public generally is unaware that automatic train-control systems have passed the experimental stage; and it will, therefore, surprise a good many people to learn that equipments of this nature have been in regular use over considerable stretches of some of our railroads for some years. Again, there are other devices which have not yet had protracted service tests but which have been developed after exhaustive research and are capable of discharging the important functions expected of them. The Interstate Commerce Commission has kept itself fully advised of this progress; and that body's recent mandatory order is a recognition of the splendid work done by our inventors towards increased safety in railroading.

Broadly stated, train-control devices are of two general classes: first, the contact type, which depends for its operation upon physical contact between an element carried on the train and an element or succession of elements located at fixed points along the roadside; and, second, the non-contact type, which is made operable by electrical or magnetic impulses without bodily touch between the roadside and the train elements. In a general way, the contact type has offered the widest field of development to the inventor, and, therefore, let us describe first some of the distinctive systems of this order.

As might be imagined, simplicity of get-up is a feature that commends itself to the railroad man; and to satisfy this desideratum was the goal sought by Harvey B. Miller when he began, in 1908, to produce an acceptable train-control apparatus. He then conceived a mechanism by which a current of electricity, in times of danger, would liberate a ratchet and thus turn on a supply of compressed air which would force down a piston that served to close the steam throttle and to apply the brakes simultaneously. This was all well enough provided the energizing electricity did not fail. Herein lay the weak point of the Miller device. Along came William B. Murray, a practical railroad man, who saw the good in the germ of Miller's invention, and who set about making it reliable and serviceable by reversing its operative procedure—that is, he produced a brand-new contrivance which would function when the current of electricity was shut off.

After three years of experimental work, the Miller-Murray invention was installed for actual service on 24 miles of track between Danville and Hoopeston, Ill., and the results were so satisfactory that a complete division of the Chicago & Eastern Illinois Railroad—a stretch of more than 106 miles of double track, was equipped with the system. Since November of 1914, this busy portion of the line has been handling successfully all of the trains that are safeguarded by this simple and withal dependable mechanism. This record is unique.

Without entering into the various details of the equipment, it will suffice for the present purpose to say that it is made up essentially of two basic elements: a track-side ramp of T-iron, located 22 inches from the running rail and extending parallel therewith for a distance of 100 or more feet, and a locomotive element, secured to the tender and terminating in a shoe, which slides along the top of the ramp and takes up current from the ramp if the latter is energized. If current is picked up, the electricity serves to unlock the control and thereby to permit the train to pass onward without stopping. On the other hand, with the ramp "dead," the plunger, which is forced upward by the shoe on engaging a ramp, induces an application of the air-brakes and, at the same time, calls into play compressed air which shuts off the locomotive's motive steam. When the brakes are so operated they remain in action until released by the engineer. The flow or non-flow of current to the ramp is determined by the angle at which the block-signal arm is set. In other words, the train-control equipment and the block-signal system are interlinked.

All movable parts of the train element are constantly under air pressure, which retains or holds them in their normal positions, and they are, therefore, not affected by vibration. Further, should the shoe or any associate feature break or fail, the compressed air is vented into the atmosphere, and this brings about a service application of the brakes. Similarly, should electricity not flow to the ramp when it ought to do so, owing to a broken wire or by reason of battery trouble, the train will be halted. These are provisions which make for safety when there is something wrong with the system and when the engineer might believe he was justified in going ahead.

In a kindred effort to produce a simple automatic train stop, mainly of a mechanical nature, Jean F. Webb, Jr., developed about seven years ago a so-called "double-action" apparatus which was tested on the New York, New Haven & Hartford Railway from 1915 to 1917. As a consequence of those trials, under all sorts of weather conditions, the inventor has evolved an equipment that meets in a satisfactory manner many of the prerequisites specified by the Interstate Commerce Commission. In its perfected form it has been tried out recently by the Erie Railroad.

Like the Miller device, the Webb equipment employs a third rail or ramp as well as a contact shoe attached to the lower end of a vertically-moving plunger. The upward thrust of the latter, when the shoe touches the third rail, rotates a cam, by means of interposed elements, and in doing so opens a valve which permits compressed air to escape from the train-pipe of the brake system. The escape of this air causes the compressed air in the auxiliary tank under each car to pass into the brake cylinder—thus inducing an application of the brakes.

Normally, the plunger is held downward at its maximum limit by a strong spring; and the plunger is pushed upward by the ramp against the action of this spring. Therefore, as soon as the shoe has passed over the ramp the plunger descends. If the semaphore signal is at the "proceed" position, electricity flows through the circuit of which the ramp forms a part, and this current energizes a small magnet which, in its turn, moves a little armature. This armature is the medium by which the descending plunger is made to close the air valve; and as the run over the ramp takes less

Courtesy The Miller Train Control Cor.

At the right of the road can be seen one of the train-control ramps. There are 175 of these ramps at suitable points along the tracks between Danville and Chicago.

than a second, at a speed of 30 miles an hour, the application of the brakes is merely momentary. The air that is allowed to escape from the train-pipe is utilized to blow a whistle in the cab; and the engineer and his fireman are put on their guard in this manner every time a ramp is encountered. Inasmuch as each ramp is placed on the approaching side of its associate block-signal, and at a suitable distance from it, the men on the locomotive are given ample warning and are stimulated to be on the lookout.

If current does not energize the ramp because the semaphore is at "danger," then the plunger, on being forced downward by the spring upon clearing the ramp, is not able to close the air vent in the train-pipe line and the brakes continue to press against the wheels until the train is brought to a halt. All the while the cab whistle sounds its cautioning note. The fewness of the parts which compose the Webb apparatus is one of its outstanding features. These elements are of rugged construction; but should a shoe, for instance, break or should the electric circuit become deranged from any cause, then the train will be stopped automatically and attention directed thereby to the derangement.

The Regan automatic train-control system is the outgrowth of the Casale intermittent, electrical contact device, and is a good deal more complex and, at the same time, more comprehensive in its operative scope than any of the equipments so far described. Twenty locomotives on the Chicago, Rock Island & Pacific Railroad have been fitted with the mechanism, and along 21 miles of double track have been installed the necessary operative ramps. These ramps are formed of two parallel lengths of angle iron, bolted together and holding between them a copper insert. Each ramp is connected with the regular block-signal system and linked with a roadside battery of sixteen cells which, agreeably to the signal indication, is cut out altogether or sends an energizing current through the ramp of either positive or negative polarity.

To be specific, if the way ahead is clear, and the train can safely advance at full speed, the current fed to the ramp is positive in character. If however, the signal calls for caution and lower speed, so that the train can be brought to a stop within a comparatively short distance, then the ramp is energized by current of negative polarity. Should the signal be set at "danger," the ramp is "dead" in an electrical sense, and the automatic apparatus, through the contacting shoe suspended at one side of the tender, causes an emergency application of the brakes by which the train is quickly brought to a standstill. Whenever the signal is at "caution," the negative current brings into play an automatic speed controller mounted upon the locomotive, and this ingenious apparatus checks the velocity of the engine within the block if it exceed the rate of travel prescribed in the name of safety.

It should be understood, of course, that the shoe mechanism is designed to pick up electricity from the ramp and to facilitate the passage of current on to various associate mechanisms which are placed upon the locomotive for the purpose of controlling the compressed air of the braking system. The shoe is held firmly against the ramp by compressed air, which is led to the cylinder enveloping the plunger to which the shoe is secured. This plunger is drilled axially throughout nearly its whole length—being sealed only at its lower end, and should the shoe be broken off a passage would thus be opened for the escape of the compressed air. This would instantly cause a drop of pressure in the train-pipe and induce an application of the brakes.

It should be explained that the locomotive equipment includes a battery of six cells, and from this source is obtained the current for operating the train-control system when the shoe is not in contact with a ramp. In other words, the upward movement of the plunger cuts out the locomotive circuit and introduces the ramp circuit in its stead. The locomotive circuit dominates the speed-control mechanism when running between ramps. What might be called the heart of the system is a triple relay carried on the locomotive, and this, in its turn, affects the action of an electro-magnet which controls an electro-pneumatic reservoir and brake valve. It does this by venting the train-pipe and closing the valve of the reservoir or by reversing these two functions agreeably to whether the train is to be stopped or to be left free to go ahead. The Regan system includes visual or audible cab signals for the purpose of warning the engineman or the fireman should either fail to observe the wayside signals.

So far, we have considered automatic train-control devices which call for physical contact between a locomotive or tender element and a track-side ramp. The ramps required range in length from about 35 feet to well over 100 feet, and while it is claimed that none of these systems is likely to be put out of working condition by frost, ice, snow, rain, or mud, still there is the chance that the unexpected may happen.

It should be self-evident that steps must be taken to minimize as far as practicable the lateral blow received by the contacting shoe when it is swept against the ramp by the onrushing train, and it is equally important that the shoe be held snugly against the ramp during its sliding run along the upper surface of the ramp, otherwise there will not be a continuous flow of the needful electric current. To reduce shock, the approach and the leaving ends of each ramp are inclined oppositely—the first to raise the plunger gradually and to bring the shoe to its highest point and the second to allow the plunger to descend to its normal position without violence. Despite these precautions, the contact surfaces of the shoes are ground away and must be replaced at intervals, and occasionally a fault in the castings or a particularly sharp blow will break off a shoe. While such a mishap is promptly announced and stops the train so that substitution can be made in a few minutes still such a halt might lead to confusion if the breakage occurred on a section of dense traffic. These facts are not offered by way of disparagement but only to make it clear why other inventors and engineers have given much attention to devising apparatus which do not require physical contact between the track and the train elements.

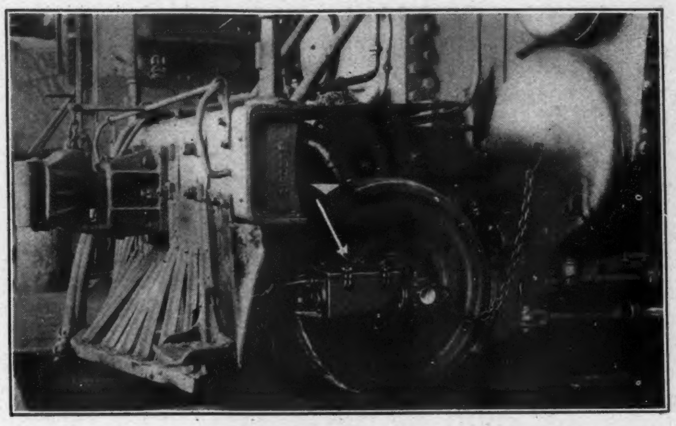
Of the non-contact systems of automatic train control we shall limit ourselves in this article to describing but two. First, let us take up the one which has been developed by the General Railway Signal Company and which has been demonstrated on the Buffalo, Rochester & Pittsburgh Railroad. This equipment is the outcome of more or less intensive study and experimentation over a period of about ten years, and, broadly, consists of a track-side element and a locomotive installation—the latter having its responsive or reciprocal feature attached beneath and at one side of the tender where it can sweep above the track-side element with a clearance or air gap of two inches.

The General Railway Signal Company has utilized the action of induction, that is a magnetic field induced by a combination of electro-magnets. The track-side element is termed the inductor, and the neighboring train element is called the receiver. The inductor is linked with the block-signal system by an electric circuit, and is, therefore, either "alive" or "dead" according to whether this circuit is closed or open. Current flows to the inductor and energizes its magnet only when the block-signal is set at a position that indicates that the train can proceed. If the block ahead is occupied, then current does not flow to the inductor, and the train is halted—the signal being set at the danger or stop position. The train equipment is made up principally of a storage battery—carried on the tender, a receiver, and an electro-pneumatic valve which controls an actuating cylinder so connected that it will force the engineman's brake lever to the service position whenever the circuit of the electro-pneumatic valve is open—that is, when electricity is not flowing through the circuit.

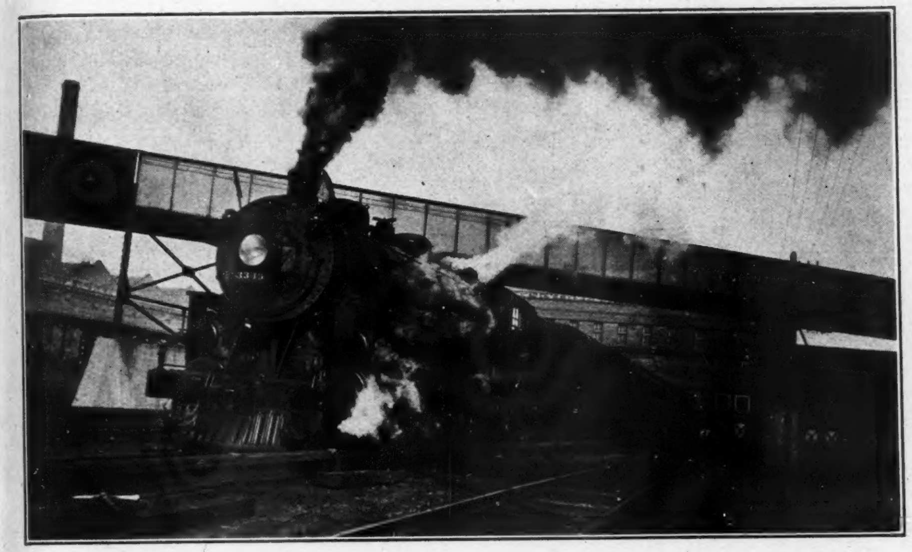
In principle, the receiver is a duplicate of the inductor save that its position is inverted. The laminated iron magnet has a heavy coil of insulated wire at each end. The system depends entirely upon the reactions set up by induced magnetism between the inductor and the receiver, during their momentary nearness to each other, and according to these the electro-pneumatic valve is or is not actuated. When the brakes have been applied automatically so as to halt the train, they cannot be released until a push-button has been pressed, and this button is located where it cannot be reached except when the train is standing. In connection with the system there is provided an "acknowledging contactor" both for the engineman and for the fireman. If these contactors are operated simultaneously whenever a restrictive signal is passed this operation will forestall the automatic application of the brakes. This feature serves to compel the engineman to call the fireman to witness that they are passing a restrictive signal, and, therefore, each is thus made aware that caution must be exercised in advancing.

The Sprague system of automatic train control has come into being after a decade of collaboration on the part of Frank J. Sprague, an electrical engineer of world-wide reputation, and his son F. Desmond Sprague. Their apparatus is likewise based upon the utilization of magnetic induction, and by reason of the specially designed magnets employed they find

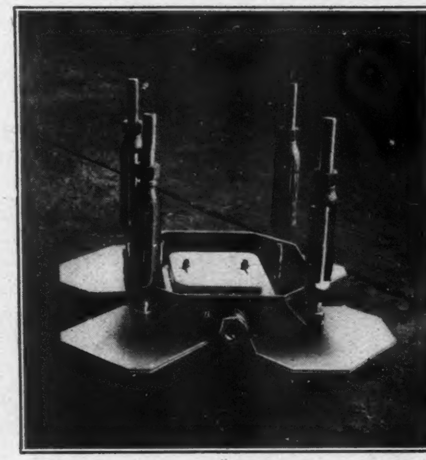
Testing a track magnet. If the magnet is in proper working condition the portable receiving apparatus will give a telltale click.



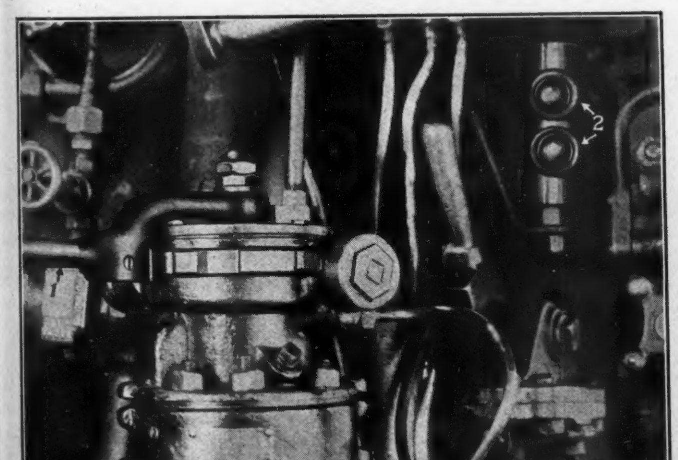
The speed-control mechanism is attached to an extension of one of the truck axles. This apparatus can be set to bring about the application of the brakes whenever a locomotive exceeds the maximum safe speed required on entering a caution block.



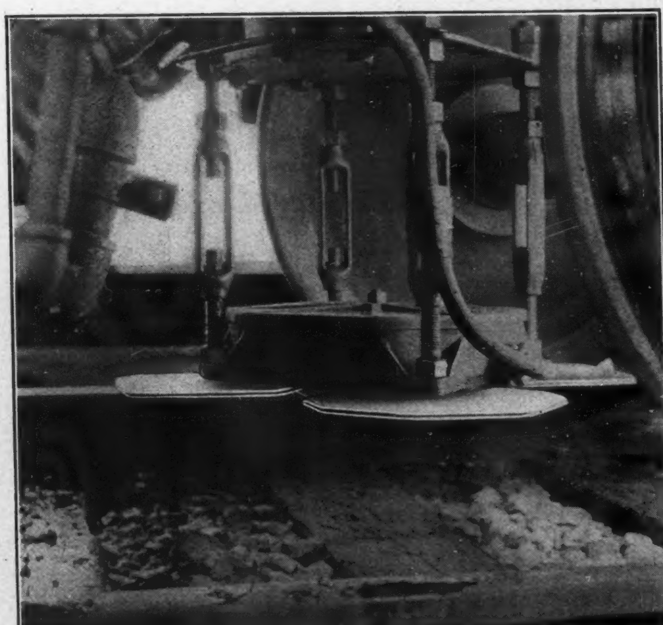
Test train, equipped with the Sprague system, starting out on a demonstrating run.



An interior view of a Sprague magnetic receiver. Two of the outspread plates catch the impulses from re-set magnets and the other two iron fins respond only to the flux of the brake-application magnets. Within the central casing are the little magnets which make or break certain operative electric circuits.

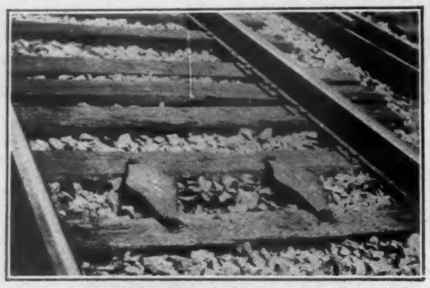


A close-up of the engineer's brake control valve (1) as modified to suit the Sprague system. The two small arrows at the right (2) indicate the yellow and the green cab signals. Similar electric lights are in front of the fireman on the other side of the cab.



Photos, Courtesy, Sprague Safety Control & Signal Corp.

The magnetic receiver in position beneath the forward end of the tender. It is hung from three to four inches above the tops of the rails and, therefore, clear of any obstruction that would pass under the cow catcher.



Courtesy, Sprague Safety Control & Signal Corp.

All that is visible of a brake-application magnet: the two pole pieces. The casing containing the connecting bar magnets, lies between the sleepers and beneath the rock ballast.

it entirely practicable to make the inciting, invisible flux span a gap of seven or eight inches between the track and the associate train element. This interval safeguards the train element against harm from any object or projection along the right of way over which a locomotive's cow catcher could pass.

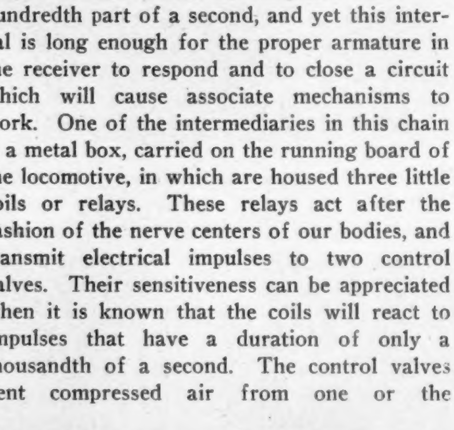
At the present time the Sprague system is installed for demonstrating purposes on a five and one-half mile section of the New York Central Railroad, where a special train is operated seven hours daily for six days a week. The division of the road of which this section is a part is electrified, and for this reason the circumstances are such as would be likely to subject the automatic train-stop equipment to the severest possible operative conditions. Even so, the apparatus has worked without a hitch during the several months that have followed since it was put in place.

We can only touch upon the high points of this very ingenious system which has been devised to give the engine driver the fullest measure of command provided he does not fail to heed the various warnings of the wayside block-signals. Within each block are located three magnets, the tops of which rise only a couple of inches above the ties between which they are placed. Shortly after entering a block, a locomotive overruns the first of these magnets, which is capable normally of causing an application of the brakes. At a point farther along in the block, the engine encounters a second brake-application magnet of the same type, and when nearing the signal at the far end of the block, the locomotive comes to a third magnet, of a different kind, which is intended ordinarily to reset the apparatus on the engine, that is, to restore it to service readiness.

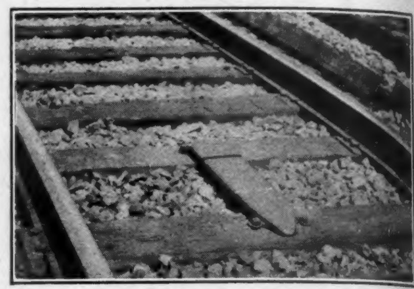
The brake-application magnets are permanent magnets which continually generate a magnetic field above them unless an agency is called into play for the deliberate purpose of neutralizing or blanketing this flux. This can be done by permitting a current of electricity to energize two coils which are mounted on the two pole pieces of each of these magnets. The reset magnet is an electro-magnet, and is inert unless current is fed purposely to its energizing coil. These several magnets are so connected with the block-signal system that they act in unison with the semaphores or the lights of the wayside signals. For instance, if a train enters a clear block, the brake-application magnets are nullified by the electricity which flows through their coils. On the other hand, should the semaphore be set at "danger," no current will flow through the coils and the magnets will be able to exert their full force in setting in motion the allied mechanisms on the train which lead to the venting of compressed air from the train-pipe—thus operating the brakes. Should the connections with the block-signal circuit become deranged at any time and from any cause, then the brake-application magnets will exert themselves and stop a train. This is a precautionary measure which insures a margin of safety in all circumstances.

How, you will ask, are the magnetic impulses picked up by the speeding train? How can the relatively feeble fields of the magnets be effective in controlling the ponderous mass as it thunders along on the rails above? The Spragues have made this possible by devising what they call a "double receiver." This is a metal casing, equipped with four horizontal iron plates and carrying inside of it two small metal bodies or armatures which are so mounted that they are exquisitely responsive to the faintest flux from the road-bed magnets and yet insensitive to the jarring and motion that cannot be avoided in railroading. The two side wings or collector plates are alert only to the fields of the brake-application magnets, while the front and the rear plates are unaffected save by the flux of the reset magnets. Each set of plates, in its turn, acts upon its own armature in the receiver.

When a train at high speed passes over a magnet it cuts across the magnetic field in a hundredth part of a second, and yet this interval is long enough for the proper armature in the receiver to respond and to close a circuit which will cause associate mechanisms to work. One of the intermediaries in this chain is a metal box, carried on the running board of the locomotive, in which are housed three little coils or relays. These relays act after the fashion of the nerve centers of our bodies, and transmit electrical impulses to two control valves. Their sensitiveness can be appreciated when it is known that the coils will react to impulses that have a duration of only a thousandth of a second. The control valves vent compressed air from one or the other of two piston chambers, and the consequent movement of this piston opens or closes certain ports and in this way regulates the manner in which the brakes shall be applied from end to end of the train. These valves may be set to insure any suitable combination of light and heavy applications of the brakes under the run of service conditions as well as to give the fullest application of the brakes when meeting the sudden demands of an emergency. All the while, it is practicable to assure the engineer a good deal of freedom of action so long as he does not violate the warnings transmitted to him or try to exceed the restrictive limits imposed upon him by the prescribed adjustment of the valves. In short, these valves and, therefore, the entire apparatus can be set to meet the traffic needs of any road and any type of train.



Pilot control valves which regulate the flow of compressed air and thus bring the brakes into service according to the way in which the valves are set to meet the particular traffic needs of a railway.



Courtesy, Sprague Safety Control & Signal Corp.

A reset magnet near the exit end of a block. This magnet restores the apparatus on a locomotive to its initial responsive condition.

Associated with the system is a speed-control mechanism. This part of the apparatus becomes active whenever a train enters a block showing a signal at "caution"; and at such times the brake-application magnets will cause the train automatically to slow down to a predetermined speed. If the engineer deliberately push his train along faster, the reset magnet will, under those conditions, induce an emergency application of the brakes and bring the train to a standstill, and the driver, thereafter, cannot proceed until either he or the fireman has stepped down from the cab and pressed a releasing button.

Further, let us say, that colored lights and a sound signal in the locomotive cab advise both the engineer and the fireman of the passing of each magnet and of the nature of the warning, while the forcible shifting of the air-brake lever, by a hydro-pneumatic attachment, gives to the engineer's hand a tug which tells him that he must slow up. The Sprague system is designed, in effect, to repeat the signal which is displayed at the approaching end of each block, and by this means to inform the men on the locomotive what may be expected in the block ahead. A "caution" block invariably precedes a "danger" or occupied block. The automatic apparatus can be counted upon to supersede the driver if he fail deliberately or unintentionally to heed either the block signals or those other signals which are transmitted to him in his cab.

Enough has been said to make it plain that automatic train-control devices have been sufficiently perfected to make them fully capable of meeting the requirements specified by the Interstate Commerce Commission.

Compressed Air Roof for Paul Poiret's Paris Theatre

By BEN K. RALEIGH

PAUL POIRET, the miracle man of silks, satins and laces, the noted Parisian creator of feminine fashions, has lately been working with other materials intended for a totally different purpose. While Paul Poiret's reputation is primarily founded on the skill with which he designs women's gowns, etc., it is undeniable that he is also a shrewd business man.

In order that the world of fashion might see what they had to offer, it has been the practice with Parisian *couturiers* to send their manikins arrayed in the latest mode, to the race-tracks. This was all well enough for sport clothes and outdoor frocks; but what Poiret wanted was a place where he could display exclusively, in suitable surroundings, all of his creations for every occasion. He therefore conceived the idea of building a theatre, one so unique, and offering such unusual attractions, that the public would actually come and pay admission to view the wonderful costumes turned out by his establishment.

The theatre is located in the garden which has always been a part of the Maison Poiret, and is appropriately called *Théâtre de l'Oasis.* Until half-past seven in the evening, the flowers hold sway in all their loveliness in their accustomed habitat, but by eight o'clock a transformation is wrought and the blooms vanish. In their stead, there is laid a carpeted floor—in short, a platform and a stage are called into being seemingly from nowhere, and comfortable chairs are provided for the expected audience. Please remember the *Théâtre de l'Oasis* is not of the familiar housed-in sort.

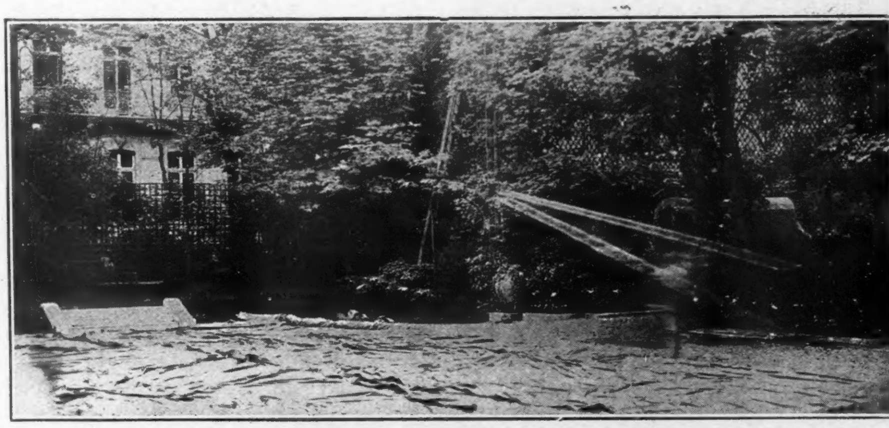
To guard against the rain, and yet to be out in the open, a most ingenious roof has been conceived which comes into being at night as magically as the rest of the theatre itself. The problem of devising such a protective covering was turned over to Monsieur Gabriel Voisin, a French pioneer in aviation. Monsieur Voisin, after deliberation, came to the conclusion that there was but one agency by which a roof could be spread over the theater in the time available for the purpose, and that was by compressed air. The so-called compressed air roof was finally made by the Nieuport-Astra Company of Paris.

Now let us see how this flexible covering is raised every evening over the site of Poiret's novel playhouse. A well-trained crew of men is necessary to do this work, and these, together with the bulky roof, arrive at the garden by automobile at the appointed hour. First, a large linen cloth is laid on the ground, and on top of this the pneumatic envelope is unrolled and placed in proper position. The linen merely serves to protect the fabric from injury through contact with gravel, etc. Strong wire cables are secured to the walls of adjacent buildings and to the ground, and these sustain the roof when aloft. With these preparations finished, the ingenious shelter is ready to be inflated. Here is where compressed air performs its important function. But, as there is no compressor on the premises, the question is: "Where is this vital buoyant medium to come from?"

In Paris, compressed air, like gas, electricity and steam, is distributed throughout the city from a central station by an underground network of piping, and is always available. Therefore, in order to inflate the collapsible roof at Maison Poiret, the workmen need only connect two lengths of hose, attached to valves on the envelope, with a corresponding number of valves in the compressed air main. The roof is divided up into compartments. Two of these compartments run lengthwise, and communicate with all of the transverse subdivisions so that the air, fed into the longitudinal sections, can find its way into every corner of the big bag, for such it really is. To fill the envelope sufficiently is a matter of something less than 25 minutes. By means of winches, and the cables already referred to, the roof is hoisted into position.

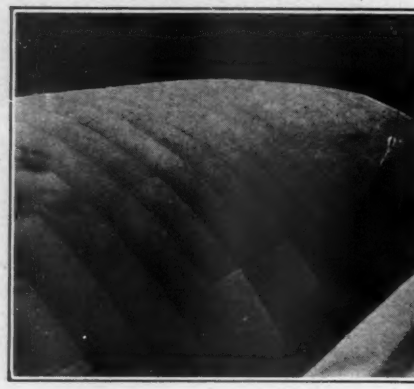
A separate tent-like shelter, which covers the stage only, is next quickly erected. There is no time to lose. While the roof is being raised and the stage prepared, the floor of the auditorium is promptly laid; and then, by the aid of inclined planes, the chairs and the tables are slid into place from their daytime repository into the cellar of the establishment. It has taken just three-quarters of an hour for this mushroom theatre to come into existence.

Let the rain now fall if Fate so decree. Milady will be safe and cozy beneath the air-filled roof; and the very latest of Poiret's creations may come upon the stage without fear of injury. A survey of what was so shortly before a garden reveals a perfect setting for the *couturier's* art. Whether Poiret



Roof fabric spread out upon the ground in preparation for inflation.

Theatre de l'Oasis with the pneumatic roof raised over the auditorium.



A close-up of the roof from above.

employs a comedy, a drama, or a musicale as an atmosphere in which to introduce the raiment of his conception, all of the characters are dressed true to their parts. In passing, it should be remarked that Poiret has deemed it wise to appeal to the inner man as well as to the eye, and refreshing iced drinks are served during every performance.

Presently it is time for the audience to trickle in. From the moment the big velvet curtain, which shields the garden from the street, is pushed aside by a liveried flunkey until the same white-wigged individual bows one forth again to every-day life, the spectator has the feeling of having taken part in a sumptuous *fête* at some princely chateau. Beneath the pneumatic shelter, a gay audience reclines comfortably in large arm chairs that are covered with gay chintz; and an orchestra of eighteen pieces furnishes music. The period of enjoyment goes on without cease until the wee, small hours of the morning.

After the performance, the auditorium is dismantled just as rapidly as it was called into being; the roof is lowered, deflated, carefully rolled up, and carried away in the truck to a near-by storage place in readiness for the next evening's entertainment. Has this experiment paid for itself in a material sense? Well, from now on, take note of the number of American women who mention casually that they picked up one or two "little Poiret gowns" during their trips abroad. And right here, let it be said that the compressed air roof, as much as any other contributive factor, lent its aid in selling those creations.

Though strictly utilitarian, the roof has been designed, both in color and in form, with due regard to beauty. It is made of a combination silk-and-linen fabric, of a deep oriental yellow, and is so put together that, when inflated, it becomes a succession of undulations as it arches overhead. For those who are interested in figures, let us say that the awning weighs a little more than half a ton; that it is 72 feet long and 52 feet wide; that there is a distance of 28½ feet between the floor and the under side of the highest point of the envelope; and that it is inflated by the compressed air to a uniform thickness of approximately five feet. The tent over the stage has a length of 37¾ feet and a width of 59 feet.

INDUSTRIAL WASTE AND RAILWAY GAGES

IN THE EARLY days of railroad construction little thought was given to a matter so apparently unimportant as the gage of the tracks. There had never been any great uniformity in the gage of wagons. Any reasonable distance between the wheels that might suggest itself to the builder would answer as well as another. It thus came about that a great variety of wagon and carriage gages existed and, as the railway car was but another type of wagon, the same lack of uniformity crept into its construction, resulting in a hodge-podge of gages that did not make for the economic interchange of merchandise.

The track gage which has long since become the standard—four feet eight and one-half inches—was the favorite from the start. This is accounted for largely by the fact that wagons running on rude tracks drawn by horses in British coal mines had been in use a long time before the advent of the steam engine. The gage of these wagons was fairly uniform at the distance now standard, thus affording something like uniformity in certain districts. No thought, however, of the necessity of getting together on a gage that would permit an interchange of equipment between lines e[illegible] entered the heads of the early railway bui[illegible] ers. The roads they built were purely lo[illegible] affairs and it was inconceivable that th[illegible] could ever be anything in common between [illegible] line, say from Providence to Worcester a[illegible] one from Jersey City to Paterson or, in En[illegible] land, between one from Liverpool and Man[illegible] chester and one from London to Bristol.

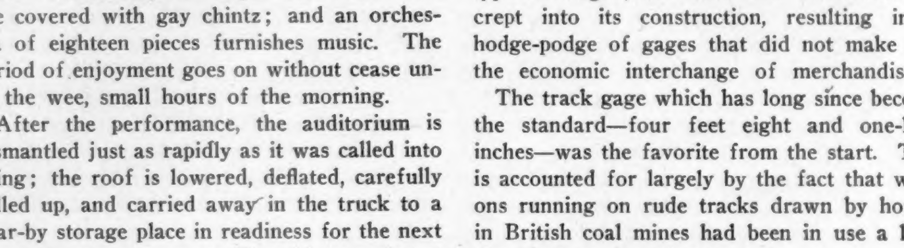
Most of the early New England railroa[illegible] were originally built to the now standard ga[illegible] Ohio, after seeing a variety of gages come i[illegible] use in that state, established by law a ga[illegible] of its own—four feet ten inches. This w[illegible] looked upon as good business on the part [illegible] the Buckeye State because a change in ga[illegible] meant that all freight must break bulk at h[illegible] borders and that all passengers must chan[illegible] cars. The greater part of the Louisville a[illegible] Nashville system and many of the lines [illegible] the Southern states were built to a 5-fo[illegible] gage; from New Orleans northward the pop[illegible] lar gage was five feet six inches. In northe[illegible] New York State some of the smaller pro[illegible] erties that have since come under the wi[illegible] of the New York Central were built to a ga[illegible] of four feet nine inches—a difference of [illegible] a half an inch from the now standard [illegible] just enough to render equipment intercha[illegible] impossible. In Missouri five feet six inch[illegible] predominated. Many lines throughout t[illegible] country were built to a gage of three fe[illegible] three feet six inches and four feet. T[illegible] Erie railroad had adopted six feet and stu[illegible] to it long after many other roads had chang[illegible] over to standard. In order to make its [illegible] equipment last as long as possible it laid [illegible] third rail over some of its line and operat[illegible] on both the six-foot and the standard—oft[illegible] with the locomotive on one gage and the tra[illegible] on the other.

The great bulk of our mileage, however, w[illegible] originally laid down to the gage that has sin[illegible] become the standard. This is true, also, [illegible] Great Britain and continental Europe [illegible] though many gages of strange dimensions e[illegible] tered into their original construction as we[illegible]

The period of transformation was, generall[illegible] in the early 80's when most of the lin[illegible] that had to move a rail in or out to meet th[illegible] standard did so—usually over night or over [illegible] Sunday. The L. and N. moved a rail ju[illegible] three and one-half inches in over 2,090 mil[illegible] of its main and branch lines in a single da[illegible] Sunday, May 30 1886.

But although the American railroad gage [illegible] now a standard thing and although much th[illegible] same may be said of the greater part o[illegible] Europe, the gage of the railways of oth[illegible] continents is far from being standardize[illegible] Australia is struggling along with five differe[illegible] sets of gages on its 27,000 miles of line an[illegible] would like to standardize but can reach a[illegible] agreement upon which of its five-fold colle[illegible] tion to choose. In South America may b[illegible] seen all sorts and conditions of gages.

It seems that the Siberian fur market i[illegible] now almost entirely in the hands of Americ[illegible] firms, who maintain branch offices or buyi[illegible] representatives at Harbin, Chita, and Urg[illegible] Mongolia.



A transverse section of the pneumatic roof and its associate features.

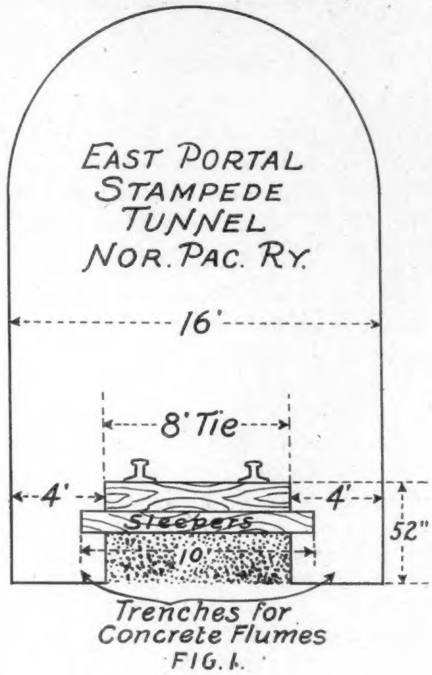
Amplifying the Drainage Facilities of the Stampede Tunnel

By C. W. BUCKLEW

THE STAMPEDE TUNNEL in the Cascade Mountains, through which the Northern Pacific Railway operates trains, was built years ago. Recently it became necessary to provide additional facilities extending from the summit to the east portal of the structure. This called for rock excavation on each side of the track between the ends of the ties and the neighboring tunnel walls, and something like 260 feet of this work was done in solid concrete. For this job the contractors employed an outfit consisting of one 14x14x12 in. "FR-1" compressor, ten CC-25 paving breakers, eight tie tampers, nine BCR-430 "Jackhamers," and one "Leyner" sharpener.

The excavation for the flumes was approximately four feet wide and about 52 inches in depth, on each side of the tunnel; and in the rock work, where blasting was required, the "Jackhamers" were used to drill holes in the center of the space between the tie ends and the tunnel walls. These holes were about 40 inches in depth and spaced twenty inches from center to center. The paving breakers were employed to trim the rock after shooting, and also helped in the removal of some comparatively loose rock.

After substantially all of the concrete flumes were in place, the railroad company decided to reballast the entire length of the tunnel, which is two miles long. This involved raising the track and getting rid of some old sleepers which were under many of the ties and parallel with them, Most of these sleepers were about ten feet in length and fourteen inches square in cross-section, but some of them measured 12 by 12 in. and 10 by 16 in. in cross-section. To aid in clearing away these underlying ties, two of the paving breakers were equipped with a steel, resembling a carpenter's chisel, which had a width of face about 2½ in. Paving-breaker steel was utilized for these tools. So outfitted, the two paving breakers were worked opposite each other, and with them a V-



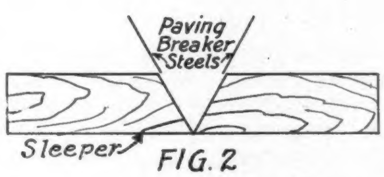


Fig. 1 is a cross-section of the tunnel. Fig. 2 indicates the manner in which paving breakers were employed to cut away the old sleepers.

shaped cut was made in the center of each sleeper. It took but a few minutes to go through the largest of the timbers. The paving breakers, as a rule, were employed primarily for breaking the 260-foot length of concrete; and the tie tampers have done the retamping of the track.

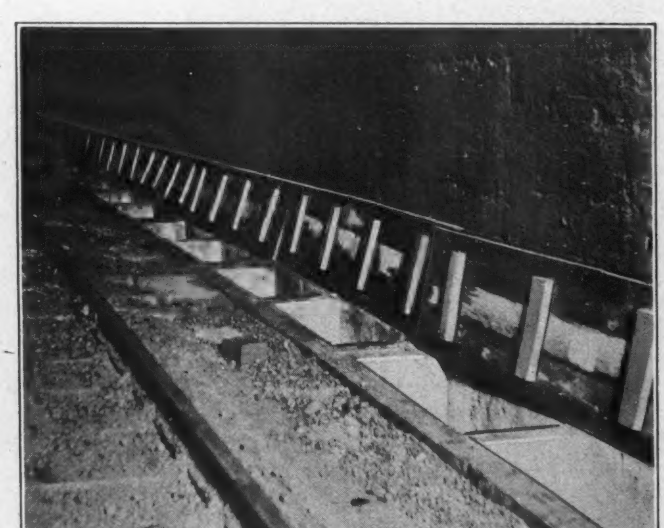
The average load on the compressor involved as nearly as possible the simultaneous operation of five "Jackhamers" and six paving breakers. The pressure carried at the compressor was around 90 pounds; and the air was piped from the east portal to the summit, a distance of about one mile. The equipment was used at an elevation of 2,900 feet. No attempt was made at a speed record by the contractors, the Winston Brothers Company of Minneapolis, because of the confined space in which the work had to be executed, and owing to the fact that care had to be taken to see to it that nothing interfered with the maintenance of the regular train schedules. The road through the tunnel is single track.

A NEW GAS FOR AIRSHIPS

From Los Angeles comes word to the effect that Dr. Edward Curran, head of the research department of a new aerial navigation company, has developed a new gas, Currenium, for airships. The new gas is said to be the outcome of several years of intensive study and experimentation. The company owning the formula is preparing to engage in the manufacture of the gas by an electrolytic process at a cost, it is estimated, of about $100 per thousand cubic feet less than it costs to produce helium. According to a witness of the demonstrations, the new gas has a lift about the same as pure hydrogen, but is non-inflammable and non-explosive, says *Scientific American*. However, it remains to be seen whether the gas is all that is claimed for it, when it is once produced in commercial quantities.

A news item is in circulation to the effect that Secretary of Commerce Hoover has indorsed the metric system. Mr. Hoover cannot understand how the report originated. He says that he has not indorsed the compulsory use of the metric system.

Excavating trench for flume on one side of the track.



A finished concrete flume at the side of the tunnel.

COMBATING FOREST FIRES WITH COMPRESSED AIR

COMPRESSED AIR is invading the wilderness, being employed in the capacity of combating modest woodland conflagrations. The Forest Service of the United States Department of Agriculture has introduced the departure in a limited way in California and other states in the Pacific Northwest. This application of the compressed air spray, necessarily, is confined to fresh outbreaks or to what the forest fire fighter terms "spot" or camp blazes, in reality, incipient conflagrations.

© U. S. Forest Service.

Compressed air spray and tank used in suppressing small fires.

The compressed air spray and tank, the latter having a capacity of four gallons of water, are portable. The outfit is secured to a pack-board which makes it easy for a man to carry it on his back, or the equipment may be transported by a pack animal. Blazes started by careless tourists or campers may be thus quelled in the absence of more pretentious fire-fighting appliances, and at a minimum of labor and expense.

OZONE FOR SEASONING TIMBER

A process for seasoning timber by means of ozone has been developed at the Sorbonne, Paris, by Professor Otto, and is claimed to give results in twenty days equal to those obtained naturally in several years. The process consists simply in exposing the wood to a current of ozone-charged air. The color remains unchanged, and microscopic examination is reported to have shown that ozone-dried oak and walnut have the same characteristics as ordinary air-seasoned wood. The experiment seems to have reached the commercial stage, as Italian and French companies are, it is said, arranging to work the process.

Through the efforts of the coal operators of western Pennsylvania, another year of extensive research work in coal mining will be conducted by the Co-operative Department of Mining Engineering of Carnegie Institute of Technology and the Pittsburgh Experimental Station of the U. S. Bureau of Mines.

DRILL STEEL—BITS AND SHANKS

[Drill steel has always been a much discussed subject and it probably will continue to be as long as there is rock to drill and blast. We are continually receiving letters asking for advice on various phases of this subject. Most of these questions and their answers are of interest to a large part of our readers, and therefore this column is published in order to give our readers the benefit of the service that we have been rendering through this correspondence. Questions are especially invited which have to do with any phase of forging, tempering and the care of drill bits and shanks. Our answers, based on the best modern practice, will be published in succeeding issues.—Ed.].

Compressed Air Magazine,
New York City.

DEAR SIR:—I am a contractor having had experience for the past fifteen years in drilling all kinds of rock. I was somewhat surprised the other day when my blacksmith told me that a drill bit had to be tempered differently for varying hardnesses of rock in order to get the best results for that particular condition. I have always contended that a bit tempered for the hardest rock would be satisfactory for softer formations. I should appreciate your valued opinion on this subject.

New York City. T. J. W.

In giving you our opinion we should like to go briefly into the theory of the heat treatment of steel. A good grade of commercial drill steel will contain about .85 per cent. to .90 per cent. carbon. The decalescence point, or what is sometimes called the upper critical point, occurs about 1380 degrees Fahrenheit for steel of this grade. This is the point at which the decomposition of pearlite to austenite occurs with the accompanying loss of magnetism in the steel. If a bit forged on a piece of steel of the above grade, whether it be hardened previously or unhardened, is heated up to the upper critical point and suddenly quenched in cold water, it is hardened at a point where the grain structure of the steel is the finest. The metal in this condition possesses the best structure which hardened steel is capable of assuming.

In heating to the upper critical point it is advisable to obtain a temperature of about 1440 or 1450 degrees Fahrenheit, which is somewhat higher than the actual upper critical point to insure that the steel is heated throughout and to allow for a certain loss in heat which occurs between the furnace and the tank.

A bit which is tempered in cold water at the above temperatures is suitable for drilling soft rock as well as hard rock. Any change in the treatment of the steel from the above cannot improve its grain structure and consequently could not be expected to show as good results in any kind of rock. The best bit made is none too good for drilling rock.

Compressed Air Magazine,
New York City.

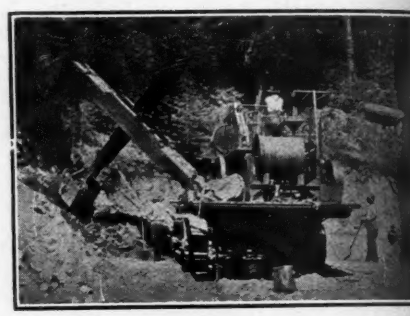
DEAR SIR:—We are employing five paving breakers to tear out concrete foundations, and are having trouble with the steel points breaking off. My blacksmith assures me he is tempering them just as he does his "Jackhamer" bits. Can you help me out?

El Paso, Texas. K. S. (Engineer.)

Your trouble can be eliminated if you will temper the steel points in oil. The points used for this work are so thin that they are extremely brittle when quenched suddenly in water. By quenching in oil, the points will be toughened and have greater resistance to fracture.

EXCAVATING BY COMPRESSED AIR OPERATED CONVEYER

THE ACCOMPANYING photo shows how a compressed air conveyer operating in conjunction with a steam shovel carried the excavated material to a point along the bank which would have been impossible with the steam shovel working alone. The shovel emptied its contents into a four-wheel truck which was drawn up an incline by compressed



Steam shovel at work. The truck operated by compressed air.

air power and automatically dumped its contents high on the bank. Using compressed air for handling excavated material is becoming a common practice in many places. Notable among these applications is using a small compressed air hoist in connection with a drag scraper which has reduced to a great extent the amount of manual labor involved.

THE CREST OF THE SIERRA NEVADA

The highest point in the United States, Mount Whitney, is not an isolated mountain peak like Mount Shasta or Mount Rainier, which are old volcanoes, but is a summit in the great tilted block of the earth's crust, forming California's saw-tooth range, the Sierra Nevada. The top of Mount Whitney stands 14,501 feet above sea level.

The German merchant fleet is rapidly expanding, according to figures recently reported by the United States Department of Commerce. It has been unofficially estimated that the Teuton tonnage now amounts to approximately 1,619,000 gross registered tons. Eight ships were launched during June, aggregating 66,600 tons; eight were completed during that month, totaling 48,600 tons; and seven were purchased in the same interval, amounting to 22,200.

San Francisco's Hetch Hetchy Water Suppy

PART III

The Structural Features of the Dams for the Lake Eleanor and the Hetch Hetchy Reservoirs

By NELSON A. ECKART and LESLIE W. STOCKER

IN THE TWO preceding installments we covered the general scheme of the Hetch Hetchy project and some of the constructional facilities brought into play to expedite work on this great undertaking. The present article will be confined to an account of the two great dams which are to serve in impounding vast quantities of potable water for the Metropolitan area which is to be supplied from the mountain sources.

Lake Eleanor Dam

Lake Eleanor will eventually be the second largest reservoir of the Hetch Hetchy system. The watershed of this lake furnishes part of the flow of the Cherry River, from which water is taken to operate the construction power plant. During the dry season this flow is reduced to a very small quantity.

To store water to operate the power plant through the late summer and the fall months, a low dam has been built on the site of the future high dam and will constitute a part of the ultimate structure. The reservoir thus formed has a capacity of 28,000 acre-feet, with the high water-line 4,660 feet above sea level. The annual floods amount to several times this quantity of water, and fill the reservoir early in the spring of each year.

The dam is of the buttressed arch type, 1,260 feet in length and 70 feet in maximum height above the stream bed. The maximum depth of water at the upstream face is 60 feet. The dam contains 11,640 cubic yards of concrete and 262,000 pounds of reinforcing steel. There are twenty arches, each of 40-foot span, and 460 feet of gravity wall. Of this wall, 200 feet is constructed as a spillway, with removable flashboards. A log chute is also provided in this section. Over the entire length of the dam is a reinforced concrete slab roadway, twelve feet wide, with galvanized iron railings.

The stored water is withdrawn through two 24-in. sluice valves, placed on the face of the dam. In addition, two 24-in. scouring valves are located at the bottom of the dam. The face of the arch is inclined at an angle of 50 degress from the horizontal, except the upper seven feet, which are vertical. The radius of the arch barrel is 23 feet in the horizontal section. The thickness normal to the face is about three feet at the bottom and fifteen inches at the top. An unusual feature of the design is that the horizontal section of the arch, and not the normal section, is a circular arc. The dam was built entirely by day labor in about nine months' working time, and at a cost of about $290,000.

The ground conditions were unusually favorable to construction. Bed-rock was exposed on the entire site except at the ends; sand and gravel deposits were conveniently available; and timber, which had to be cut to clear the reservoir basin, was sawed up for form lumber. The excavation for foundations was carried five to fifteen feet below the surface, which was sufficient to reach perfectly sound rock free from seams and to assure proper keying of the arches and buttresses to the rock. This work was begun September 1, 1917. Two months later the pouring of concrete commenced, and at the end of seven more weeks the objective for the season had been attained, i. e., to build the dam to a height, before heavy snowfall compelled the discontinuance of the work, which would permit construction to proceed in the following spring without interference due to high water. Temporary openings were left near the base of the dam for the passage of floods.

A large quantity of cement was brought to the work in the fall and was stored through the winter in anticipation of difficult transportation over the new road the following spring. Sand and gravel for concrete aggregate were taken from a moraine formation near the site of the dam. At the sand and gravel pits, traps were built of ample height to permit the installation of screens and the loading of trucks by gravity. Four-horse Fresno scrapers were used for placing the material on the traps. The sand and gravel were delivered to large bunkers, slightly higher than the crest of the dam. Under the bunkers, narrow-gage, side-dump cars were operated by gravity to a one-yard mixer, located on the crest of the dam. The mixer discharged into one-yard, bottom-dump cars, which were handled to and from the con-

The sand pit, four miles upstream from the Hetch Hetchy dam, whence sand for the concrete work is obtained.

crete placing chutes by endless cables, operated by single-drum, steam hoisting engines. The plant was both cheap and efficient. The capacity for an eight-hour shift, including time consumed by shut-downs, was about 100 cubic yards; and a maximum pour of 130 cubic yards was made.

The arch forms were carried up in sections of about ten feet in height. Trestle work to support the forms was raised as the work progressed, in bents twenty feet in height and to a point eight feet above the floor-slab.

The upstream face of the dam was finished with a ¾-in. coat of gunite applied by the aid of compressed air.

Hetch Hetchy Dam

This dam is now being built to about three-fourths of its ultimate height, and is to be completed when the demand for increased water supply and power development justifies the additional investment. The accompanying drawing of the "maximum section" shows the extent of the two installments. Some of the principal characteristics of the dam are given in the following table:

	INITIAL DAM	ULTIMATE DAM
Type of Dam	Concrete, Gravity Section, Arched in Plan	
Radius of upstream face at crest	700 feet	700 feet
Length on crest........	600 "	900 "
Height of crest (roadway)		
Above stream level.	226 "	312 "
Above lowest point in foundation....	344 "	430 "
Depth from stream level to bedrock		
At toe of dam, maximum	101 "	101 "
At lowest point in foundation	118 "	118 "
Width at top..........	15 "	25 "
Width at base, maximum	298 "	298 "
Type of Spillway	Channel Siphon	Around End of Dam
Volume of concrete, cubic yards	375,000	625,000
Elevations, feet above sea level:		
Roadway on dam..	3,726.5	3,812
Spillway crest	3,719.75	3,800
Stream bed at upstream face	3,500	3,500
Depth of reservoir from spillway crest ...	220 feet	300 feet
Capacity of reservoir:		
In millions of gallons	67,000	113,500
In acre-feet	206,000	348,500

About 80 per cent. of the volume of the initial dam will be cyclopean concrete, which, in this case, is 1:3:6 concrete, with at least ten per cent. of large stones or "plums" embedded. In the upstream's face, in the cut-off trench, as well as for the lower layer of concrete against the bed-rock, and, indeed, wherever the maximum assurance of impermeability is desired, a 1:2½:5 mix is used. The design was based upon a maximum stress in the concrete, under conditions ordinarily to be considered, of 25 tons per square foot or about 350 pounds per square inch, with an allowance of 10 per cent. additional stress under the worst possible temporary conditions.

Inspection passages and drainage wells are provided. The latter are built up of porous concrete blocks. Radial expansion joints, sealed by bent copper water stops, are spaced at intervals of about 97 feet.

Construction of the Hetch Hetchy Dam

To by-pass the river around the dam site, a tunnel 23 feet high, 25 feet wide, and 900 feet long was driven through the solid granite of the south canyon wall. A steam engine-driven compressor plant was installed for the preliminary work, as electric power was not then available. Three of the twelve outlet conduits of the dam will be installed in this tunnel.

A rock-filled, timber-crib diversion dam 40 feet high and 321 feet long, turns the water into the tunnel. It is sheathed with a double layer of two-inch plank, with tarred burlap between the layers. The continuation of the sheathing below the ground surface is a row of Wakefield sheet piling extending down about 25 feet through sand and gravel to an impervious stratum a few feet in thickness. The maximum depth to bed-rock was over 100 feet; and there was, of course, a possibility, or, as many thought, a probability, that the underflow between the impervious layer and the rock would be so great as to require a cut-off wall to be sunk to rock. Anticipating this contingency, the contractor provided himself with cutting edges and other equipment so that, on short notice, he could sink caissons, which, however, proved unnecessary.

A low backwater dam was built near the downstream end of the tunnel where bed-rock was close to the surface. Excavation in the dam site was then carried to completion with little difficulty due to water.

Except in the high water season, the water entering the foundation pit was handled by one 8-in. and three 6-in. centrifugal pumps, operating about one-third of the time. At the peak of the spring flood the water was 33 feet deep at the diversion dam and 146 feet above the bottom of the foundation excavation. One 14-in., two 8-in., and three 6-in. centrifugal pumps were then worked continuously.

Excavation Methods

Excavation on the side walls and in the cut-off trench above the stream-bed level was carried on by drilling with "Jackhamers" and by shooting and barring down the material to the river bed, where it was loaded into trains of narrow-gage, 4-yd. side-dump cars by a Marion No. 36 steam shovel on caterpillar or crawler treads. The trains were hauled by 18-ton saddle-tank locomotives to a waste bank near the crusher plant, and the excavated material was dumped there so that rock suitable for plums as well as for concrete material can be readily re-excavated as desired.

On reaching the river-bed level, a steam shovel was used in excavating the foundation pit for a depth of 65 feet, to Elevation 3,435. In the lower part of the steam-shovel excavation, the trains were run on a very steep incline, with a maximum grade of twenty per cent. The trains were worked on a counterbalance system: the empty train, entering the pit, helping the loaded train up the steep grade.

Below Elevation 3,435 the track grades became too steep for train haulage and the space between the solid rock walls too narrow to permit economical use of the steam shovel. Derricks were then resorted to to lift the excavated material out into skips and to empty the skips into the trains, which from that time forward were operated on trestles along the steep side walls of the dam site.

At Elevation 3,439 at the downstream toe, bed-rock was encountered and a concrete retaining wall, 31 feet in height, was built, sealing off all seepage into the lowest portion of the foundation. At the upstream toe, on reaching Elevation 3,435, a cofferdam was sunk to bed-rock, Elevation 3,399, and a concrete retaining wall was poured, cutting off practically all seepage into the pit proper. These walls also prevented a great quantity of loose material, up and down stream from the dam site, from sloughing down into the pit, particularly at the upstream toe, where layers of fine sand, acting like quicksand, were encountered.

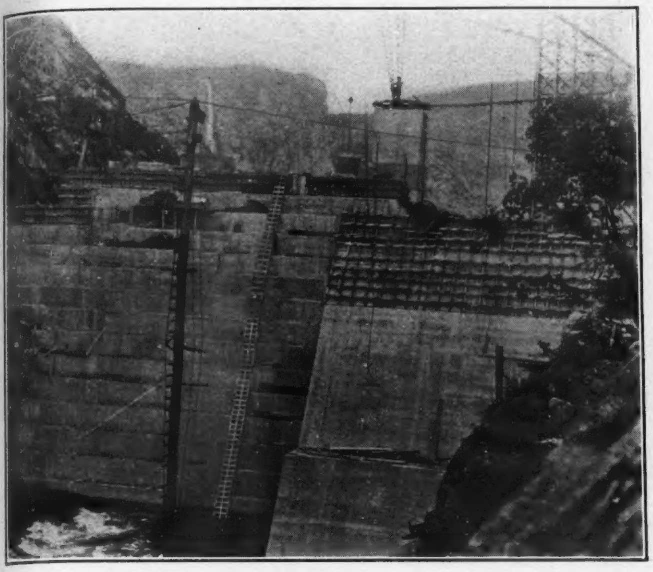
All surface rock which had been exposed to weathering was removed, leaving a freshly broken surface to receive concrete. Below the original river level, where weathering had not occurred, a great part of the rock surface was simply sand-blasted by compressed air to remove scale and soft pits and to roughen surfaces which had been polished by the action of water and glacial ice. The total excavation was 165,000 cubic yards, of which 100,000 yards was solid rock.

Construction Plant and Heavy Equipment

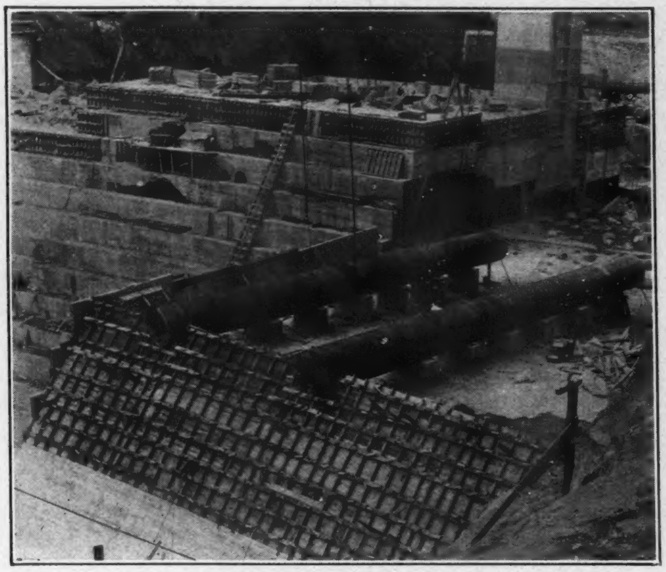
To handle the material from the deep excavation, and later to place plum rock in the cyclopean masonry, one steel derrick with 100-ft. boom, one with 110-ft. boom, one wooden guy derrick with 70-ft. boom, and one with 60-ft. boom were installed on the dam site. These so overlap as to cover all points in the lower portion of the dam. To operate in conjunction with the derricks, a high railroad line was built on the south abutment, at Elevation 3,540, connecting with the valley railroad system which is north of the river, by crossing on the diversion dam, and another track was placed at the same elevation on the north abutment. Dumping platforms were arranged on these railroads, enabling the derricks to unload directly into the dump cars lifted by the 3-yard skips from the foundation pit. Now that concrete work is under way, the derricks handle plum rocks from flat cars and drop them, without interfering with the pouring operation, wherever it is desired to embed them in the freshly poured concrete to form cyclopean masonry.

A 15-ton, 2¼-in. Lidgerwood cableway, with a span of 903 feet, supported on towers 528 feet above the bottom of the foundation pit, and having a speed of 900 feet per minute, extends over the dam site. Machinery, industrial locomotives, and other heavy equipment, lumber, timbers, etc., are handled by this cableway from the cars on the track of the Hetch Hetchy Railroad to the narrow-gage cars of the contractor's construction railroad on the valley floor level. The drop from one track to the other is over 300 feet. Employees are lowered or raised to and from their work in a skip, suspended from the cableway, carrying 52 men.

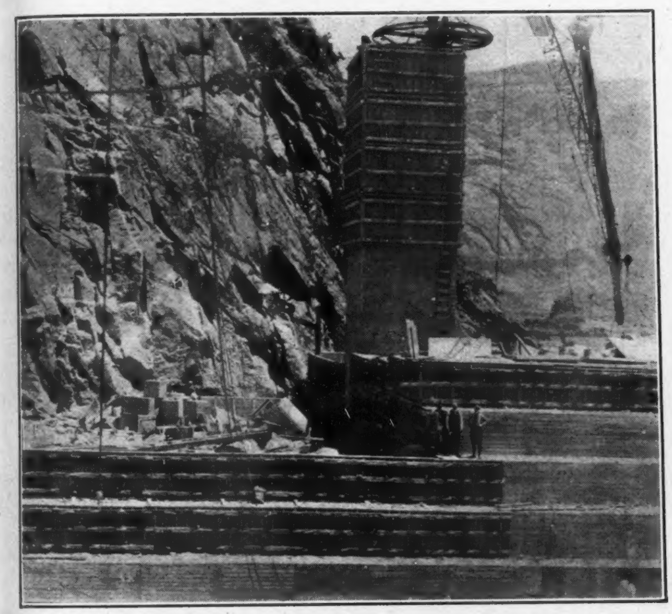
The contractor's narrow-gage industrial railroad on the valley floor extends from the dam site to the head of the valley, a distance of about four miles, terminating at the Rancheria Creek sand pit, and passing the Falls Creek gravel pit, the crusher, and the



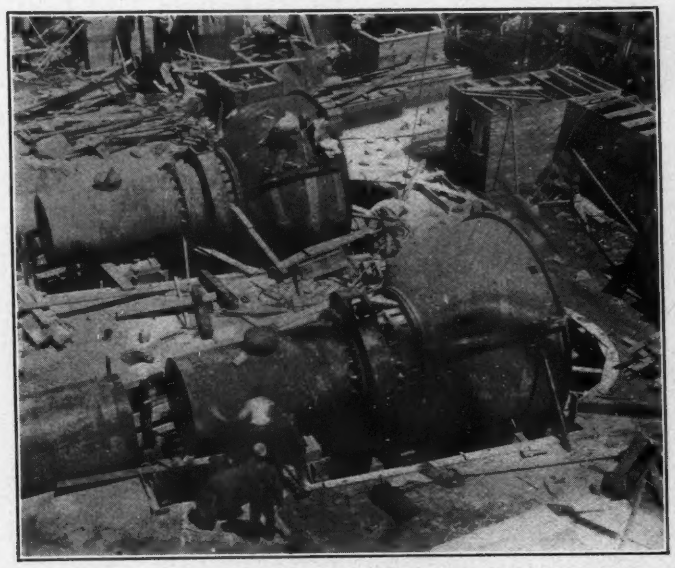
The downstream face of the structure. Each step on the main section has a rise of five feet.



The forms of the 5-foot outlet conduits. All told there will be six of these big outlets.



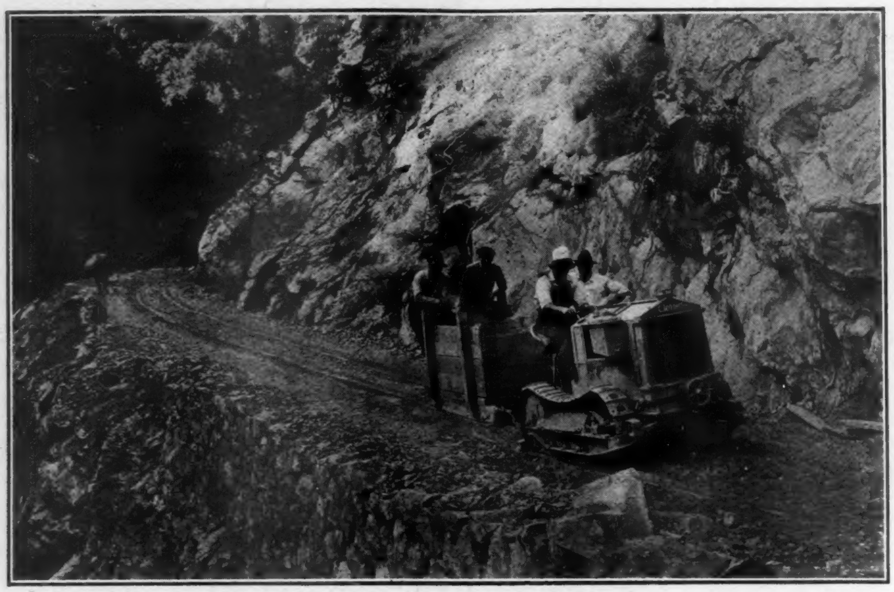
The downstream side at the north end of the dam. The stepped construction is to facilitate bonding with the future addition by which the dam will be raised 85 feet more.



The housings and outlet conduits of two of the six 5-foot balanced valves.

The upstream face of the dam. The men on staging at right are applying a coating of mortar with the cement gun.

Slide gate-valves, 47 by 90 in. with hydraulic operating cylinders, controlling the flow of the water to the semi-circular wells in which the big balanced valves are to be set.



The South Fork Canyon road. The caterpillar tractor answers admirably in climbing this steep gradient.

sand-screening plants. The rolling stock includes ten 15-ton locomotives, eighty-two 4-yard dump cars, and twelve flat cars. The maximum grade is 1½ per cent., which permits a 15-ton locomotive to haul ten 4-yard cars loaded to capacity with sand.

This railroad was built to haul the excavated material from the dam foundation to the dump in the valley; to bring sand and rock from natural deposits and from the dump and quarries to the crusher plant for screening and crushing; and to haul the crushed rock and clean sand to the concrete-mixing plant at the dam.

All cement, except the relatively small quantity required for concrete blocks and miscellaneous small jobs, is delivered to the work in bulk. The box cars in which the cement is brought to the dam site via the Hetch Hetchy Railroad are emptied by means of an unloader, consisting of a small motor-driven winch which drags a flat board scraper. The cement falls from the car doorway into a hopper, from which a 12-in. screw conveyer takes it to a storage bin 150 feet away. This bin is 60 feet long, 32 feet wide, and 34 feet deep, built with a V-shaped bottom, making the entire 15,000 barrels of capacity (about 70 car loads) live storage. From the bin a 12-in. screw conveyer, 120 feet in length, carries the cement to a weigher house. This conveyer runs through a 4-ft. by 6-ft. tunnel beneath the storage bin. Slide trap-doors along the sides of the tunnel release the cement from the bin.

The weigher house is equipped with two 1200-pound capacity Hoepner scales with automatic feed and cut-off arrangements. Electrically operated signals, consisting of flash lights and horn sounders, and an independent telephone line, provide means of communication between the weigher house and the mixer house, which is 180 feet lower down.

When released from the weighers, the cement falls through two 8-in. steel pipes, on a one-to-one slope, to the cement measuring bins near the mixers. These bins serve to give a volumetric check on the quantity of cement being charged into the mixers, but are used only occasionally for that purpose.

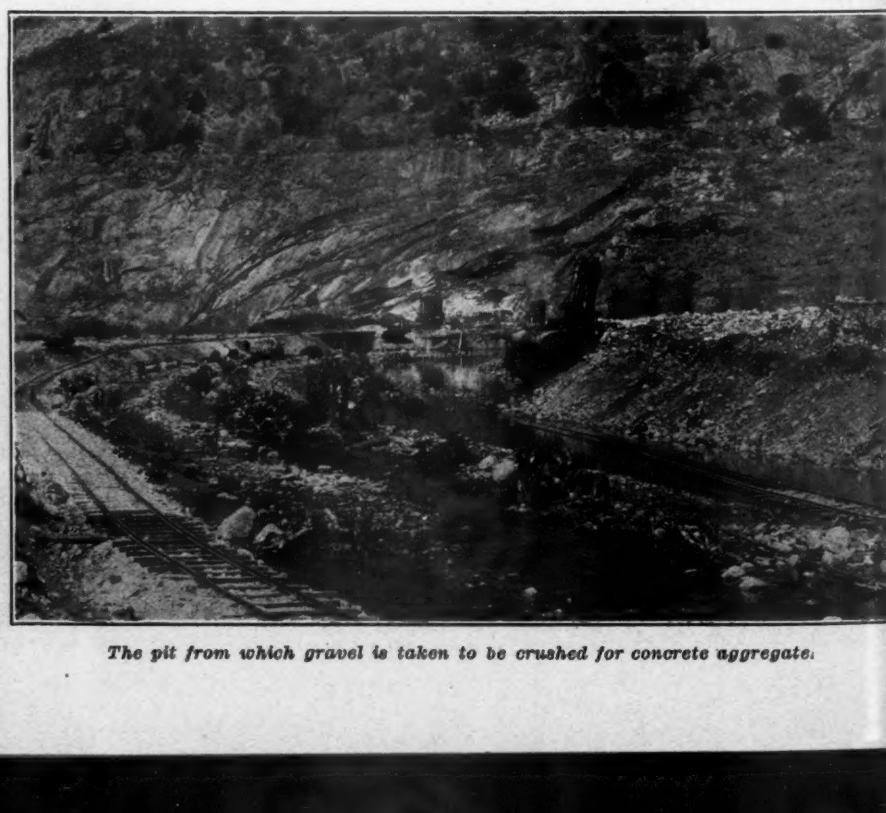
The great bulk of the sand for concrete is being excavated by a No. 31 Marion steam shovel from a pit near Rancheria Creek, four miles upstream from the dam. The excavated material is about 75 per cent. sand and 25 per cent. gravel. It is loaded by the shovel into ten-car trains of four-yard dump cars, and then hauled to the sand-screening plant over three miles distant.

About 1½ miles from the dam, near Falls Creek, there is a deposit of gravel and boulders, which is the principal source of coarse aggregate. About 80 per cent. of this material is composed of gravel and of boulders—the latter measuring up to one cubic foot in volume. It is excavated by a 70-ton Bucyrus steam shovel and is loaded into 4-yd. cars for transportation to the crusher plant.

Plum rock for embedding in the cyclopean masonry is obtained from a talus formation near the crusher plant. The boulders range in volume from three to 25 cubic yards, and are broken with powder to sizes varying from one to five cubic yards. They are excavated by a Marion No. 36 traction shovel, and are loaded into skips on flat cars. All plum rock is washed with a high-pressure spray, and, when necessary, wire brushes are used.

The rock-crushing plant is located on the valley floor, one-half mile upstream from the dam. The cars from the Falls Creek pit are hauled up an inclined track, having a 1½ per cent. grade, carried by trestle; and their contents are dumped over a grizzly with bars spaced six inches apart. The material passing the grizzly falls onto a 30-in. belt conveyer, while the larger cobbles and the small boulders roll into the hoppers of the primary crushers—a No. 36 Kennedy-Van Saun gyratory and a 26 by 42-in. Kennedy-Van Saun jaw crusher, respectively of 150 and 100 cubic yards capacity per hour. These reduce the rock to a maximum size of six inches and discharge it onto the same conveyer, which raises its load to a rotary screen.

The upper section of this screen has a half-inch mesh. All fine material screened out is wasted, as it contains too much organic matter—not removable even by thorough washing—to be acceptable for concrete. The lower half has 2½-in. holes. The ½-in. to 2½-in. material screened out here drops onto a second belt conveyer. The coarse material retained, i. e., 2½-in. to six inches in size, goes on to the two secondary crushers. These are a No. 6 McCully gyratory and a No. 49 gearless, belt-driven, Kennedy-Van Saun crusher, set for crushing to 2½-in. The capacities of these machines, on the hard granite rock which they are crushing, are, respectively, 50 and 100 cubic yards per hour. The re-crushed rock falls to the second conveyer, and, with the finer material previously mentioned, is then elevated to the final screen, which is of ¼-in. plate with ⅜-in. holes. The fine material, from ¼-in. down to dust, is received on one belt conveyer, and the coarse from ¼-in. to 2½-in., on another, both elevated to a trestle 38 feet high and unloaded into



The pit from which gravel is taken to be crushed for concrete aggregate.

Screens in the Lower Cherry aqueduct through which water is led to the Early Intake power plant. Before the installation of these screens pine needles and other vegetable matter reached the canal and ultimately clogged the grizzly screen at the penstock.

their respective stock piles, one on each side of the trestle. The capacities of these piles are 6,000 cubic yards of rock and 1,000 cubic yards of sand. The fines thus produced and segregated are thoroughly mixed with the natural sand from the Rancheria Creek pit by running them through the regular sand plant.

Under each stock pile is a trap tunnel with mining dump doors through which the sand or rock is loaded by gravity into four-yard, side-dump cars for transportation to the concrete plant. The spacing of the doors, fourteen feet on centers, permits all the cars of a train to be loaded without moving the train. The output of the crusher plant is 150 cubic yards of rock and 25 cubic yards of fine material per hour. The sand plant screens about 75 cubic yards per hour.

This is located close to the crushing plant. The trains from the sand pit are run up on a trestle fifteen feet above the ground, under which a bunker of 200-cubic-yards capacity is located. This permits emptying a train in a few minutes. Leading from the bottom of the bunker, a bucket elevator raises the sand 65 feet and then dumps it into a narrow chute leading to a rotary sand screen. These buckets are fed by a push feeder, which makes a stroke to each bucket, and which is adjustable as to quantity of load.

The screen consists of a 42-in. by 22-ft. cylinder of ½-in. steel plate with ⅞-in. punched holes, and a 6-ft. by 22-ft. jacket of ⅝-in. heavy wire screen. This jacket is subject to change, depending on the dampness of the sand, and will be regulated to give a product not exceeding ¼-in. in diameter. The screened sand is not washed. To take care of the gravel content in the sand, which consistently runs 25 per cent. of the bulk and which rarely exceeds four inches in diameter, the material retained on the screen is led by a chute from the end of the screen to the 30-in. rock belt leading to the secondary crushers. The sand is discharged through the ⅝-in. jacket into a V-shaped hopper, which feeds the sand onto a 24-in. conveyer belt. This belt carries the sand along on a trestle 30 ft. high and 70 ft. long, and discharges the sand at any desired point by the use of a scraper. A framed tunnel beneath this trestle enables four-yard side-dump cars to be spotted under the various mining doors in the top of the tunnel and to be loaded by gravity. The output of the plant is about 75 cubic yards of sand per hour. The storage capacity is 2,500 cubic yards. The aggregates are hauled to the mixer plant in trains of twelve cars—eight loaded with crushed rock and four with sand. The concrete plant has a capacity of 125 cubic yards per hour. Sand and rock are brought to the dam site by the dinky trains from the washing and crushing plant on the valley floor, and are dumped into small receiving bins from which belt conveyers elevate the materials to an 800-cu. yd. charging bin. Below this bin are the measuring bins with inlet and outlet gates operated by hydraulic cylinders. There are two 2-yd. concrete mixers. Water for the mixers is pumped from the river into a 10,000-gallon tank on the hillside; and the quantity for each charge is measured in a steel drum mounted on the mixer.

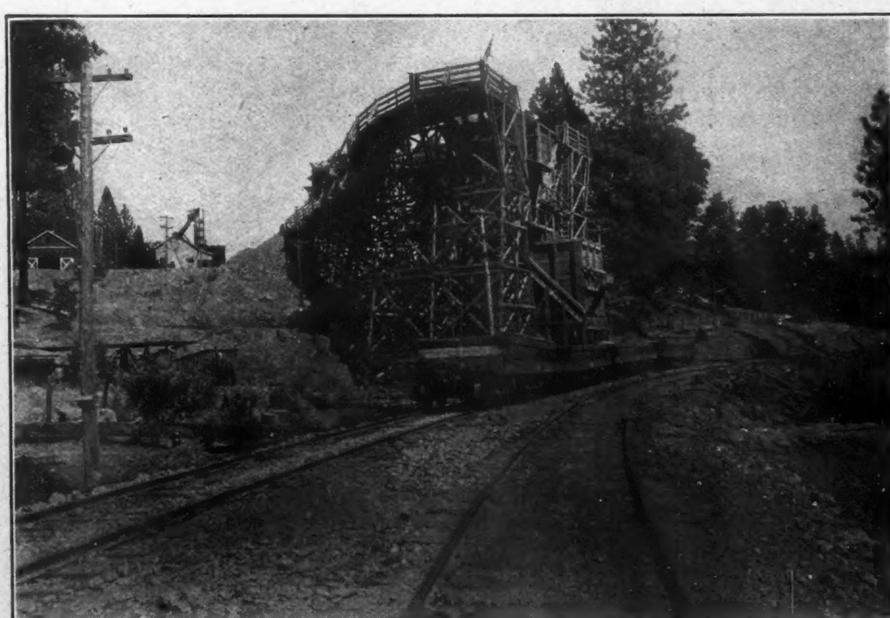
A four-compartment, timber, elevating tower is used. It is 10 by 27 ft. in horizontal dimensions, and was initially, 180 feet high, but has now been raised to its final height of 350 feet, bringing the head frame to an elevation 154 feet above the crest of the dam. The columns are four 10 by 12-in. and four 10 by 10-in. timbers, heavily sway-braced and guyed every 40 feet with ¾-in. cables. The self-dumping, one-yard, steel skips are operated independently by single drum hoists driven by 75-H.P. motors. The maximum hoisting speed is 300 feet per minute.

To distribute the concrete from the tower, two lines of 15-in. Insley chutes, with 50-ft. counter-balance sections, are used.

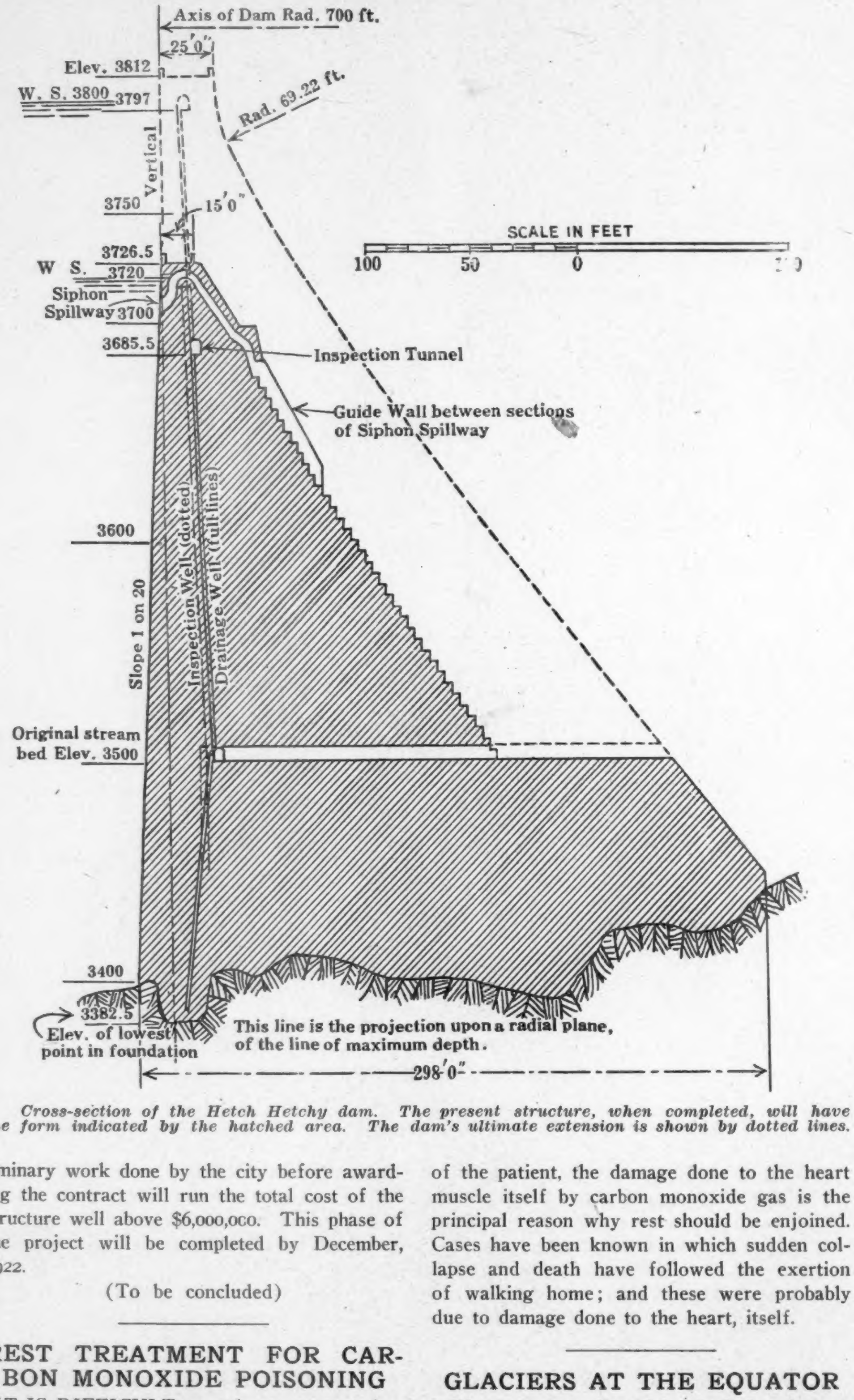
Concrete is placed in five-foot layers covering the space between two expansion joints. The original program provided for the placing of 1,000 cubic yards per day; but a day's record has been made of 1,950 cubic yards, poured in two shifts.

The 1922 schedule contemplates pouring an average of 1,500 cubic yards daily. This will be accomplished by working two shifts on the mixers, with a maximum pouring capacity of 2,000 cubic yards when running both mixers continuously. The other daily shift will be used for setting forms, for placing pipes and other metal work to be embedded in the concrete, for shifting chutes, and in giving ordinary attention to the concrete plant. As soon as practicable, after stripping the forms on the upstream face, a ¾-in. coat of gunite is applied by compressed air. This is to make more certain of imperviousness.

The dam is being built by the Utah Construction Company, under a contract awarded August 1, 1919, at an estimated cost of $5,447,792. The outlet valves and the charges for the pre-



The rock crusher plant and bunkers at Big Creek. Here it is that rock from the tunnel excavations is crushed and accumulated for subsequent tunnel lining or shipped away on the Hetch Hetchy Railroad for other uses.



Cross-section of the Hetch Hetchy dam. The present structure, when completed, will have the form indicated by the hatched area. The dam's ultimate extension is shown by dotted lines.

liminary work done by the city before awarding the contract will run the total cost of the structure well above $6,000,000. This phase of the project will be completed by December, 1922.

(To be concluded)

REST TREATMENT FOR CARBON MONOXIDE POISONING

IT IS DIFFICULT to make rescuers understand the importance of rest in the treatment for poisoning by carbon monoxide at blast furnaces, producer-gas plants, etc. The probable reason for walking men up and down who have been gassed is that the rescuers feel they must be doing something, ignoring the state of shock into which the patient has fallen. One of the essentials in treating shock, according to Dr. F. M. Legge, Medical Inspector of Factories, London, is to keep the patient warm, and, therefore, treatment in the open air is inadvisable if there is a room available. In addition to the shock and the lowered vitality of the patient, the damage done to the heart muscle itself by carbon monoxide gas is the principal reason why rest should be enjoined. Cases have been known in which sudden collapse and death have followed the exertion of walking home; and these were probably due to damage done to the heart, itself.

GLACIERS AT THE EQUATOR

We do not usually think of glaciers in connection with "Darkest Africa" or any other part of that continent, but according to the United States Geological Survey, Department of the Interior, there are small glaciers on three of the highest mountains in equatorial Africa—Mount Kilimanjaro, 19,321 feet high; Mount Ruwenzori, 16,800 feet high; and Mount Kenya, about 17,007 feet high. On Kebo Peak, which is a part of Mount Kilimanjaro, there is an ice cap 200 feet thick, which fills the ravines forming glaciers, several of which extend down to points 16,000 feet above sea level and one to 13,800 feet.

DEVELOPMENTS IN AUSTRALIA

THE QUEENSLAND Government is intent upon developing the upper Burnett area of Australia with the proceeds of loans recently floated in New York City. It is authoritatively stated that the plan involves opening up the district in question for settlement for 5,000 people, and it is declared that fully 20,000 persons can easily be supported in the land to be made available. The territory totals about 3,000,000 acres, and was formerly used only for grazing purposes. Probable expenditures will total approximately $20,000,000, and of this sum $10,000,000 will be devoted to the construction of three railways to tap this region. These lines will connect with existing roads and provide access to three important ports, thus offering settlers an excellent choice in the matter of shipping facilities.

The foregoing project is but one of several big undertakings which are contemplated in the Antipodes. There are many prominent citizens in Queensland who advocate the development of the Dawson River Valley, in the vicinity of Rockhampton, concurrently with that of the upper Burnett area, by means of an irrigation system that will, it is asserted, open about 220,000 acres for closer settlement at a cost not exceeding $10,000,000. The land, so it seems, is suited to the growing of very fine cotton. The scheme includes the construction of one of the largest dams in the world in order to impound the waters of the Dawson River so that the lands to be benefited may be irrigated by gravitation. The execution of this project would include the building of a number of railways; and with the completion of the development the district should prove attractive to at least 20,000 settlers.

COMPRESSED AIR IN THE BARBER SHOP

To be quite up-to-date, the barber shop of today must be able to give so-called compressed air service; in other words, compressed air should be available for various purposes. To this end, in the leading establishments, a customer may now find a tube conveniently suspended from his chair; and through this the air is fed from the main source of supply, which is probably in the form of a flask or a tank. The air has many useful applications, and serves all the way from brushing the hair after cutting to blowing excess powder from the cheeks that have just undergone shaving.

About 60 per cent. of the ground mica produced in the United States is utilized in the manufacture of patent roofing; 21 per cent. in the making of wall paper; eight per cent. in the fabrication of automobile tires; three per cent. in the composition of fancy paints, concrete facing, and christmas-tree "snow"; three per cent. in molded electrical insulation; three per cent. in annealing, filling in rubber other than tires, printing, lithography, sizing cotton, etc.; and two per cent. in the preparation of lubrication compounds. There was a time when this mineral was most familiar to us as transparent inserts in heating stoves.

SMALL PNEUMATIC DRILL SUCCESS AS A SCREWDRIVER

By W. E. CARR

THE PRICE of our daily loaf would be a good deal higher than it is if it were not for the labor-saving machinery which has been called into being to deal with the far-flung acres of our western wheat fields. The mechanical harvester has revolutionized the problem of garnering the essential grain; and because of its manifold capabilities it is able to do a number of things in an astonishingly short while.

The manufacturers of harvesters turn out these machines by thousands every year; and to facilitate shipment they are, as a rule, sent from the factories in a knocked down condition. The problem at the central distributing points then becomes one of assembling the parts so that farmers can get the harvesters ready for service in the field. The work of putting the machines together is by no means a simple matter; and the task is not infrequently made harder by a sudden seasonal demand for prompt delivery of a large number of outfits. This can be readily appreciated when it is realized that in setting up a harvester it is necessary to drive substantially 1,700 screws, ranging in size from ⅝-in. to 2½-in.

In the course of a twelvemonth, the Northwest Harvester Company of Spokane, Wash., uses up about 80,000 pounds of screws; and it was needful for them to resort to power-driven agencies to put these 40 tons of fastenings in place in the shortest possible time. Needless to remark, it would have cost them too much to have depended upon manual driving. For a while, the management utilized electric screwdrivers. These, quite naturally, proved to be far more effective than handwork, but the motors were apt to heat excessively, and the cost of repairs was high. Further, the electric tools were rather heavy and, therefore, fatiguing for the men to hold, especially in reaching awkward positions.

The "Little David" drill in the role of a screwdriver has lessened the labor of the operative in assembling harvesting machines. It is thus possible to drive 50 screws a minute.

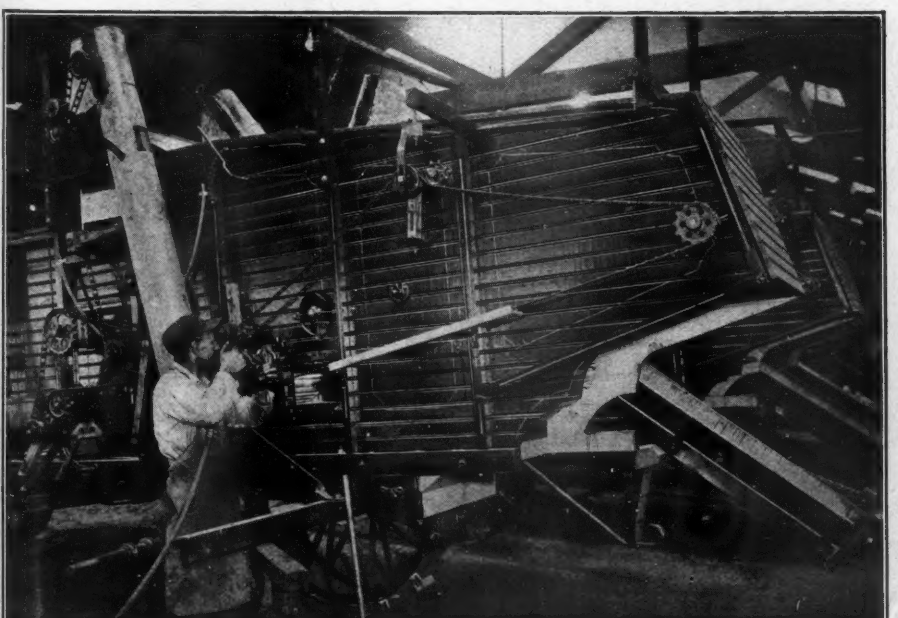
The pneumatic tool is light enough to make it easy for the workmen to drive screws quickly in awkward places.

In search for something better suited to their needs, the Northwest Harvester Company decided to test the No. 6 "Little David" air drill, and the results were so good that these tools are now supplanting the electric ones whenever the latter are worn out. The adaptable pneumatic drill weighs about one-third as much as the electric screwdriver; and it seems that the shopmen can do twice the work with it in a given interval, at a lower unit cost. In a year this means a big saving.

Owing to the constant speed of the motor, the electric screwdriver was equipped with a friction clutch. For some classes of work, the "Little David" is similarly fitted.

The plant management is now about to adapt the No. 6 drill so that it can be employed to tighten nuts; and the intention is to provide the tool with a cone friction clutch. There are several hundred bolts of various diameters in the make-up of each of the harvesters, and the largest nuts that will be handled by the pneumatic drill will be of one-half inch size. Drills of the same make are available which can handle one-inch bolts.

The success of this handy tool in this new field of usefulness instantly suggests many other departments of industry in which it could be applied to advantage.



Photos, Courtesy Northwest Harvester Co.

In assembling a Holt harvester it is necessary to drive approximately 1,700 screws. This work is greatly speeded up by using an air-driven "Little David" drill adapted for the purpose.

THE AIR LIFT—AND AIR LIFTS

WE DO NOT KNOW who was responsible for the first naming of the "air lift," the familiar and widely used arrangement for raising water by the help of compressed air. The selection of the name was not a happy one, as it is only misleadingly suggestive of the actual function of the air. There are of course air lifts for the raising of water, where the pressure of compressed air is made to act directly upon a body of water and drives the water in solid column bodily before it; but that is not *the* air lift. In the action of the latter a column of water is levitated by the distribution of air through its mass and the lifting is done by the superior weight and pressure of another and connected solid column of unaerated water.

We are not about to suggest any other name—even were we able to do so—which would be acceptable and more correctly descriptive, for the misnomer we are assured is bound to stick for ever and ever, as things do.

We only wish to suggest that we avoid evermore the use of the term air lift where it does not properly belong. We are continually being fooled by it. Air hoists are in use everywhere for the raising of solids, more numerous by far though not perhaps individually as responsible as *the* air lift where installed, but an air hoist is not an air lift.

TENSILE STRENGTH OF WATER?

The U. S. Bureau of Chemistry has been making tests of more than 500 pieces of leather taken from the most uniform part of the hide, alternate strips being subjected to dry and to damp air, all at a temperature of 70 degrees. The tests showed that an increase of relative humidity from 35 to 55 per cent. increased the strength of the leather 13 per cent., and the stretch 16 per cent. When the humidity was raised from 35 to 75 per cent., the average increase in strength was 42 per cent. and in stretch 53 per cent.

LABOR-SAVING AT THE COAL PILE

ONE OF THE large iron mining companies in the Lake Superior district was fortunate in finding available a year's supply of coal. Storage space was not sufficient to stock such an amount so the difficulty was met by enlarging the coal dock or piling the coal in such a manner that it could all be accommodated on the existing dock. The accompanying photos show how this was done, at first doing the work by hand and later using mechanical facilities.

Coal was dumped below the trestle and then graded off to allow more to be dumped. Twelve men were used for this work, six on each side of the trestle, when it was being done by hand shovelers. Some one suggested that they use a 6H "Little Tugger" hoist and a drag scraper to do the job. The mining people up in the Lake Superior district are very familiar with this scraper outfit because of its extensive use in hauling and loading ore and rock underground in the mines.

The machine shown in one of the illustrations is a small, compact, double-drum hoist which develops 7 to 8½ H.P. on 60 to 80 pounds air pressure. One of the drums is called the haulage drum and the other, the tail-rope drum. When one drum is engaged, the other runs free. The haulage rope is led from the drum directly to the front of the scraper. The tail-rope is led from the drum to a snatch block or sheave mounted conveniently behind the coal pile, and is attached to the back of the scraper by a clevis. In this way one man can operate the scraper in both its forward and backward motions, and so do all the work. Referring again to the illustration it will be noticed that this one man with a 6H "Little Tugger" hoist replaces twelve hand shovelers.

Grading a coal pile by hand. Six men shoveling on each side of the trestle.

Labor saving in grading the same coal pile with a "Little Tugger" hoist which does the work of twelve men.

A HISTORIC BUILDING BURNED

One of the most famous houses in England, perhaps the most notable for its engineering associations, was burned recently at Redruth in Cornwall. Towards the end of the Eighteenth Century it was occupied by William Murdock, then the agent of Boulton & Watt when they were installing Watt's new steam engines for mine pumping. This house is said to have been the actual place where gas lighting was first discovered by Murdock in 1792, and was the first in the world so lighted. Murdock here also invented an oscillating steam engine. Of the greatest importance is the fact that in the cellar of this house Murdock built and tested the first locomotive in 1784. He initially ran the little locomotive, apparently without rails, in Church Lane, Redruth, on a dark night. It outdistanced the inventor and so frightened the rector that he declared that he had seen the devil. The house, according to antiquaries, was formerly an ancient chapel and part of its wood work was carved and extremely old. On the east wall was a commemorative granite tablet erected by Tangye Brothers, Birmingham.

INTERNATIONAL AIR CONGRESS

It is proposed to hold in London, in June, 1923, an International Air Congress similar to that held in Paris last November. A strong organizing committee has been selected, representative of all phases of aeronautical activity, and the Congress will be open to all countries which are signatories of the International Air Convention, or are represented on the Federation Aeronautique Internationale. Lieut.-Col. W. Lockwood Marsh, Secretary of the Royal Aeronautical Society, 7 Albemarle Street, W. I., London, is technical secretary to the Congress.

The refinery established on the government field at Comodoro Rivadavia, Argentina, for the production of gasoline from natural gas has a monthly output capacity of approximately 40,000 gallons. This gasoline has a specific gravity of 0.66 to 0.72.

An Insulating Lumber from Bagasse

The Air Lift Helps in the Conversion of Sugar Cane Waste

By S. G. ROBERTS

CLEAN, FRESH WATER, and an abundance of it is doing an essentially helpful part in turning a waste product into a decidedly valuable building material.

Bagasse is the fibrous, woody refuse of sugar cane from which the juice has been extracted by pressure. Heretofore, as a rule, bagasse has been utilized by the sugar mills as fuel or has otherwise been got rid of with little thought to profit. For years, the chemist and the inventor have sought to devise processes by which the long cane fiber could be turned to better economic account, but only recently have these efforts been crowned with success in a commercial sense.

Professor C. E. Monroe, whose work in the development of modern explosives is well-known, has, after much experimenting, evolved a felted or compacted fiber-board which possesses admirable qualities and which can be used to advantage as a substitute for certain classes of lumber. In other words, the cellulose can be fashioned into sheets approximately seven-sixteenths of an inch thick, and four feet wide, which are cut into lengths of from eight to twelve feet to meet varying industrial requirements. This material, bearing the trade name "celotex," is in a fair way to add substantially to the income of the owners of our southern sugar plantations, for the cane may from now on be made to serve a two-fold purpose.

As might be expected, the first of the celotex factories is located within easy reach of a source of raw material, and is on the Mississippi River directly opposite New Orleans. At that point, as a center, the establishment can obtain from the sugar plantations lying within a radius of half a hundred miles enough bagasse to manufacture something like 200,000,000 square feet of celotex in the course of a year. Not only that, but it is entirely practicable to import bagasse from Cuba, and thus to amplify enormously the supply of the basic fiber.

The harvesting and the grinding of sugar cane is a seasonal activity, but this does not limit the making of celotex tc that particular period. Bagasse will keep in storage, and therefore can be treated at the plant long after the cane has been crushed to extract its sweet juice. Accordingly, the bagasse can be accumulated and held in readiness to insure the fabrication of celotex the year through. The raw matter carries fibers ranging from three to four inches in length, and, here, in part, we have an explanation of the reason for some of the noteworthy qualities which distinguish celotex as an insulating lumber.

The waters of the Mississippi River are not suited to the production of celotex because of the large percentage of solid matter which they carry in suspension. Consequently, it was necessary that water of the right sort be procured elsewhere, and to this end a well was bored 800 feet deep. At that depth, ground water of an excellent character was reached; and the next question was how to bring it to the surface in sufficient quantity to answer the needs of the establishment? An air lift solved the problem.

The casing, which extends down 800 feet, is ten inches in diameter. The eduction pipe, which is 283 feet long, has a diameter of eight inches, while the compressed air line is two inches in diameter. The static head or level of the water is approximately 40 feet below the ground surface, and the pumping head is about 80 feet. The starting air pressure is in the neighborhood of 100 pounds per square inch, but when the lift is in full swing this drops to around 80 pounds. The lift is decidedly efficient and delivers between 650 and 700 gallons of water per minute. This gives some idea of the amount of water required in preparing the bagasse during the several stages preliminary to running it through the rolls which press it into sheets.

For the present, the Louisiana Celotex Company is unwilling to reveal the details of their manufacturing process other than to say that the cane fiber goes, step by step, through breakers, soaking tanks, and steam cookers, by which it is washed and sterilized—suitable chemicals being added to fit the material for subsequent manipulation by special machinery. The latter apparatus build up an intimately matted mass from the pulp and at the same time force out of the forming sheet most of the water carried by the pulp when fed to the rolls. On leaving the press, the ever-growing damp sheet of celotex is moved by a conveyer into a drying room 900 feet long, where it is seasoned prior to passing through the automatic saws which cut it into marketable lengths. It takes just five hours from the moment the

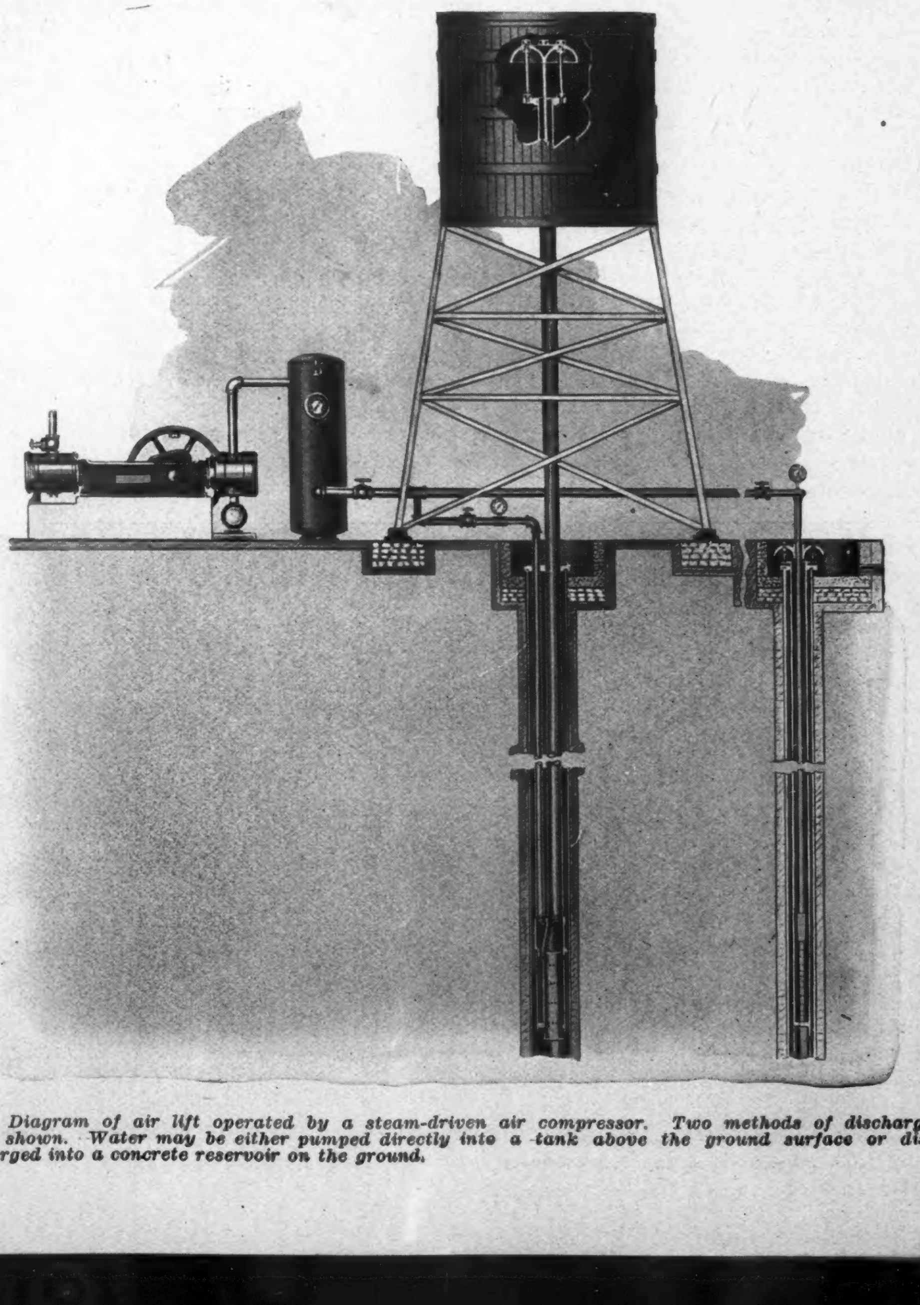
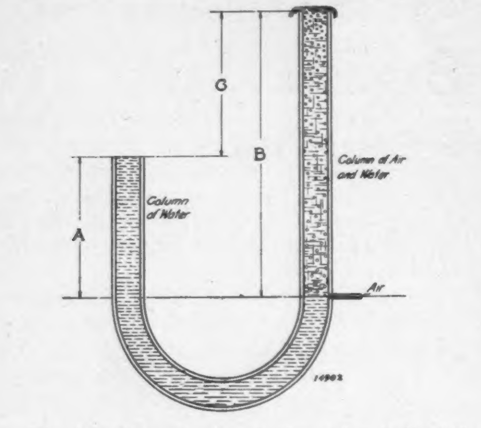


Diagram of air lift operated by a steam-driven air compressor. Two methods of discharge are shown. Water may be either pumped directly into a tank above the ground surface or discharged into a concrete reservoir on the ground.



The injection of air, at the point indicated, produces a column of mixed air and water, "B," which has slightly less weight than the solid column of water, "A." Thus the weight of the column "A" causes the water to rise the distance "C" and overflow.

The 900-foot room where the sheets of celotex are dried or seasoned while traveling upon a slow-moving conveyer.

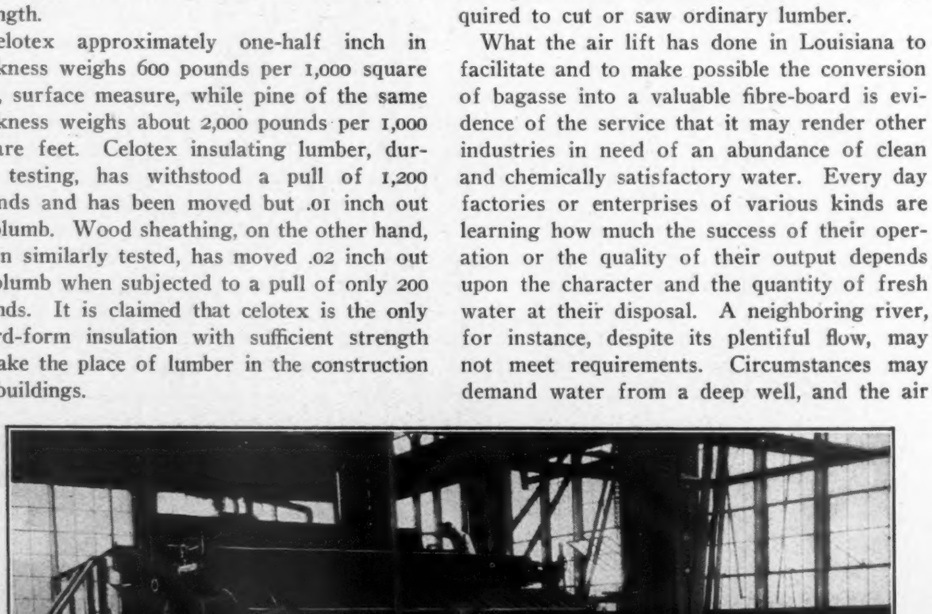
bagasse goes into the mill until it comes from the cutting machine ready for use.

Fiber-board, as such, is not a novelty—we have it in divers forms and suited to various purposes; but celotex has characteristics which commend it. It is claimed that celotex is virtually 85 per cent. air, and this accounts for its value as an insulating material. Further celotex is not built up of successive layers held together by compression: it is a homogeneous structure of intimately interlinked fibers. This explains its toughness and its marked strength.

Celotex approximately one-half inch in thickness weighs 600 pounds per 1,000 square feet, surface measure, while pine of the same thickness weighs about 2,000 pounds per 1,000 square feet. Celotex insulating lumber, during testing, has withstood a pull of 1,200 pounds and has been moved but .01 inch out of plumb. Wood sheathing, on the other hand, when similarly tested, has moved .02 inch out of plumb when subjected to a pull of only 200 pounds. It is claimed that celotex is the only board-form insulation with sufficient strength to take the place of lumber in the construction of buildings.

By reason of its insulating properties, celotex sheathing may reasonably be expected to lower heating costs. In addition to its virtues as an insulator, celotex is effective as a deadener of sound. This fibre-board will absorb but 12 per cent. of water by volume when immersed one inch for 72 hours. It will, therefore, withstand exposure to the weather. Celotex can be stuccoed or plastered, and when properly sized it may be painted, stained, or tinted. In handling the material, a carpenter uses the same tools that are required to cut or saw ordinary lumber.

What the air lift has done in Louisiana to facilitate and to make possible the conversion of bagasse into a valuable fibre-board is evidence of the service that it may render other industries in need of an abundance of clean and chemically satisfactory water. Every day factories or enterprises of various kinds are learning how much the success of their operation or the quality of their output depends upon the character and the quantity of fresh water at their disposal. A neighboring river, for instance, despite its plentiful flow, may not meet requirements. Circumstances may demand water from a deep well, and the air lift is an ideal medium for raising and delivering the water to a point of distribution. In fact, convenience to a source of raw material may necessitate the placing of a factory where surface water is not to be had. Under such circumstances ground water and the air lift may save the day, and, besides, prevent the economic sacrifice that would be entailed if the plant were established elsewhere.



Celotex insulating board issuing from the rolls and passing on to the dryer.

COMPRESSED GASES FOR HEATING

PROFESSOR F. FISCHER, Director of the Mülheim Coal Research Institute, has achieved a notable advance in heating engineering. In a series of recent experiments conducted with the assistance of several other engineers, he has demonstrated the possibility of converting heating gases, extracted from coal distillation gas, into a compressed and more efficient form.

The men who conducted this series of experiments thought it probable that such hydrocarbons as are contained in coke-oven or coal gas could be separated otherwise than by compression and cooling; that is, by a method based on the absorptive power of active coal. As a matter of fact, as active coal is able to absorb benzol and gasoline vapors from gases, it was believed by the experimenters that it might also prove capable of absorbing the lower gaseous hydrocarbons from gas mixtures, this effect being actuated by increasing the pressure.

The actual experiments showed that this assumption was correct, the gaseous components, endowed with especially high heating powers, being separated (under the action of active coal) from coal gas as well as from coke-oven gas. Professor Fischer thus succeeded in raising the heating value from 7,3[illegible] metric heat units to 19,900 metric heat units. The most effective components of coal and coke-oven gas can thus be converted into a transportable form suitable for a multitude of applications. B. K. R.

SHE WAS ALL RIGHT IN PRINCIPLE

Feminine resourcefulness took a long chance with the strength of materials recently at Tarrytown, N. Y., when the fair driver of a car drew up at a service station and asked permission to inflate the tires of her machine. After the proprietor of the establishment noticed that the pressure gage had risen to a point indicating 110 pounds, he said, "Lady, you are putting in too much air; you will blow out your tires." Unperturbed, she retorted promptly, "Oh, no I don't. My husband told me to put in 60 pounds a week, and we are going away for three weeks."

Despite depression, Japan continues to purchase iron and steel in considerable quantities. In May of the current year, that nation bought from the United States 88,[illegible] gross tons, or 5,000 tons more than in April. Japan has always been a large buyer of finished steel products from America.

How Mary Saved the Ship

The Story of a Seagoing Lamb that Carried on and, Like the Geese of Ancient Rome, Nipped Disaster in the Bud

By SIDNEY MORNINGTON

THIS IS NOT fiction but an honest-to-goodness tale of a pet lamb, Mary, that more than paid for the heed given her by a husky, hard-fisted lot of sea-dogs.

The British merchant fleet numbers among its heterogeneous make-up a sturdy Scotch craft, the *Orthia,* which, for the better part of a quarter of a century, has been engaged mostly in transporting cattle from Canada to ports of the United Kingdom. Nothing particularly eventful marked the career of this maritime drudge until recently, when Mary shone conspicuously and was instrumental in stemming the tide of disaster that threatened the total loss of the ship.

About a year ago, the *Orthia* steamed away from Montreal laden with live stock, and shortly after the ship stuck her nose into the broad Atlantic one of the sheep aboard gave birth to two lambs. Wee creatures of this sort are not welcome commonly aboard a vessel in the cattle trade, because it is generally more or less rough going for even the mature animals aboard. To make matters worse, the mother of the lambs proceeded to die after bringing her twin offspring into the world, and the fate of the lambs rested with the crew.

The forecastle gang of a freighter would hardly be expected to constitute themselves nurses for orphaned lambs. However, a rough exterior not infrequently covers a soft heart; and perhaps the Highland blood of forefather shepherds prompted the men in this case to adopt a protective course. Instead of tying a grate bar to the pair and tossing them overboard, the crew determined to see if it would be possible to bring the little creatures up by bottle. It happened that the steward of the *Orthia* possessed unusual cunning in combining condensed and evaporated milk with sea water so that the product could not be distinguished from fresh milk; and this was fed to Mary and her brother Bill who greedily accepted the camouflaged pap.

The question was then, "Could they become sailors?" For a few days all went well, and then the inquisitive and tottering Bill tumbled down an open hatch and solved the problem so far as he was concerned. Mary, displaying the adaptability of her sex, became a full-fledged sailor after a short apprenticeship. She soon learned how to avoid the pound and sweep of a sea breaking onto the deck; she proved equally wise in dodging cargo coming out of the hold when the ship was in port; and she seemed to possess an inherent sense that steered her away from exposed hot steam pipes. She knew when she could jump in safety onto a hatch sealed with battened tarpaulins; and she was careful to keep away from openings that might mean a disastrous fall. In short, Mary became, in nautical parlance, an able seaman, and for a full twelvemonth she shared the fortunes of the

The badge of Mary's distinguished service.

Orthia as that steamer plied back and forth across the North Atlantic.

And now we come to the time when Mary stood forth conspicuously and held the deck from which all but she had fled. On the night of July 4th, just past, the *Orthia* was feeling her way up to the Gulf of St. Lawrence through a fog as thick as pea soup. Slowly the craft pursued her inbound course without mishap until shortly after the hour of twelve. Then, suddenly, the freighter *Airedale* struck the *Orthia* a smashing blow and drove her bow right into the very engine-room of the cattle ship. As the *Airedale* backed away after the collision the waters of the gulf poured into the great gaping wound. The vessel was seemingly doomed, and her skipper ordered all hands to abandon the craft.

The crew was composed of naval reservists, and while there was haste in lowering the lifeboats the personnel got away from the stricken vessel in an orderly fashion. When at a safe

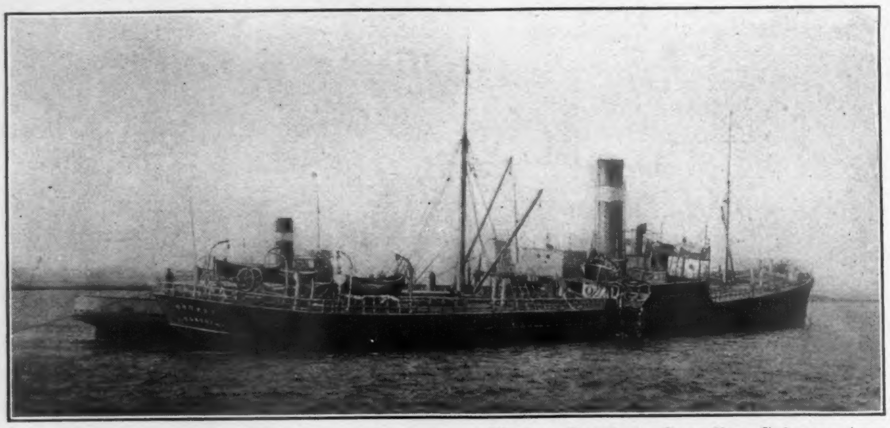
Mary and the skipper of the S. S. "Orthia."

distance, someone asked excitedly, "Where's Mary?" And finding that she was in none of the boats it was promptly suggested, "Let's pull back and get her." At that moment floated to them Mary's querulous bleat, as if in reproach of her desertion. On nearing the heeling *Orthia* the men discovered Mary standing calmly on deck, and it took some of them but a few moments to scramble aboard and to transfer Mary to the boat alongside. But having ventured back to the damaged steamer, some enterprising spirit said: "Why not take a look down the hatches and see if the forward and the after holds are filling?" A cursory examination revealed that these spaces were not as yet flooded and that they were capable, for a time at least, of keeping the ship afloat.

With Mary in safety, the crew decided to stick by the *Orthia;* and with the aid of the *Airedale* the injured craft was towed away from the deep channel and into shallow water where she might be beached before foundering. This measure was taken none too soon, considering the nature and the extent of the hole in the cattle ship's side. Mary, unquestionably, was responsible for the return of the crew in time to deal with the steamer before the invading waters carried her way below the surface of the tide. Even when beached, the decks of the *Orthia* were flooded at high water, but this, in itself, did not deter the wreckers and divers who were rushed to her aboard the tug *Gopher,* which is especially outfitted with an extensive salvage plant.

The immediate problem was that of sealing, with a suitable patch, the big opening in the starboard side of the boat; and for the nonce we shall have to defer the rest of our story about Mary. The injury that had to be closed before the *Orthia* could be pumped out and refloated reached well-nigh from the keel right up to the rail. The rent was eleven feet wide at the bottom, seventeen feet wide at the top, and extended vertically a span of 26 feet. Owing to the angle at which the *Airedale* hit the *Orthia,* much of the outer or shell plating was doubled up like the folds of an accordion, and this condition of the steel skin added materially to the hardness of the salvor's task.

The means resorted to for closing the wound consisted in the main of attaching to the outside plating of the *Orthia* a sturdy frame fashioned of 8 by 10-in. yellow pine over which heavy planking was secured. This frame was built above water, but the troublesome part of the job lay in attaching it to the ship at the desired point. Here is where compressed air comes into our tale. In order to fasten the frame to the hull it was necessary to drill a series of 1-in. holes through the sound steel around three sides of the damaged area and then to tap these holes so that they would take 1-in. threaded bolts. Most of this work had to



Photos, Courtesy Canadian Salvage Assoc.

The steamship "Orthia" aground after the collision. The gaping wound in her side is plainly visible immediately below the vessel's smokestack.

be done under water, and the divers did this aided by "Little David" air drills. It took the subaqueous toilers less than two hours to drill and to tap the holes, and a similar period to draw the frame into place. Next, the frame was planked with 3-in. spruce; and to make the patch absolutely watertight there was laid over the planking two layers of canvas hatch covers which were held in position on the edges by a line of battens.

The underwriters were apprehensive lest the *Orthia,* when she was pumped out, might break in two owing to the gravity of her injury, and, therefore, it was deemed wisest to strengthen her at the point of damage by spanning the wound with a couple of heavy steel channel-bars, bolted to the adjacent unharmed steel structure. Holes for this purpose were also made by the "Little David" air drills—compressed air for this service being supplied from the powerful compressor carried aboard the salvage tug *Gopher.* With all of the foregoing preparations completed, it was a simple matter for the *Gopher* to bring her wrecking pumps into play and to drain the flooded compartments of the *Orthia.* When refloated, the ship was taken up the St. Lawrence to Quebec where she is now being rehabilitated.

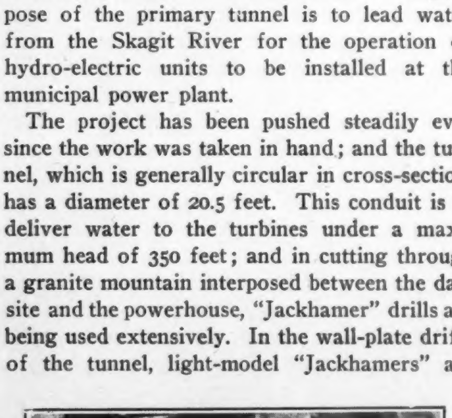
To return to Mary. That sagacious lamb trotted about the deck of the *Orthia* during the day of the steamer's refloating and was absolutely unperturbed by the thundering roar of the great salvage pumps as they drew thousands of tons of water out of the bowels of the craft and exhausted it overboard. She felt quite at home; and her right to be there was not disputed. When the vessel rose clear of the bottom, and the worst was over, one of the divers of the Canadian Salvage Association queried, "What are we going to do for Mary?" And instantly answered his own question by saying, "Let us buy her a collar." Quickly a battered cap was passed around and jingling coin was dropped into it freely. Enough money was thus collected to have tickled the vanity of Mary had she been able to understand what it was all about. In due time, a letter was written to one of the great jewelry houses in New York City—in fact, Tiffany's, and now Mary glories in the refulgence of a handsome silver band about her neck.

Stirred by Mary's story, the Lieutenant-Governor of the Province of Quebec has taken her to his heart, so to speak, and has given her a home for life on the verdant acres of his great estate. No longer exposed to the hazards of the deep, and without need of sea legs, Mary will be able to browse away untroubled in the years to come. Even though she may be unmindful of how she helped to save a ship, still her handsome collar will bear witness to the occasion of her distinguished service.

THE SKAGIT RIVER HYDRO-ELECTRIC DEVELOPMENT

A YEAR AGO the Department of Public Works of Seattle, Washington, opened bids for the driving, through rock, of a main pressure tunnel 10,978 feet long and for other subsidiary tunnels and excavations. The purpose of the primary tunnel is to lead water from the Skagit River for the operation of hydro-electric units to be installed at the municipal power plant.

The project has been pushed steadily ever since the work was taken in hand; and the tunnel, which is generally circular in cross-section, has a diameter of 20.5 feet. This conduit is to deliver water to the turbines under a maximum head of 350 feet; and in cutting through a granite mountain interposed between the dam site and the powerhouse, "Jackhamer" drills are being used extensively. In the wall-plate drifts of the tunnel, light-model "Jackhamers" are employed in place of single-jacks; and they are also resorted to in trimming and in block-holing boulders in the small drifts. In short, these tools are helping materially to save time and to reduce the labor item.



Light model "Jackhamer" helping to develope the power of the Skagit River.

Seattle, like many other enterprising communities, is fully alive to the economic potentialities of White Coal; and her present undertaking is indicative of still greater things which she may do in the future towards utilizing the latent energy of nearby falling waters.

COMPRESSED AIR USED EXTENSIVELY IN MUNICIPAL SHOPS

COMPRESSED AIR is used extensively in the municipal shops operated by the cities of Los Angeles, Oakland, and San Francisco.

The blacksmith shop, maintained by the engineering department of Los Angeles for repairing the equipment employed by the Departments of Bridges and Structures, Street Construction, Street Maintenance and Replacing, Street Improvement, Street Cleaning, Sewer Construction, etc., etc., is provided with an 800-pound hammer operated by compressed air. The compressor is driven by a 25-horse-power electric motor and has a capacity of 150 feet per minute. In order to save space the compressor tank is mounted on a staging outside the shop.

The municipal machine shop, which keeps in running order all automobiles and trucks belonging to the various city departments, has an air compressor which supplies motive air for divers purposes. In the sheet-metal division of this plant there is a large water tank for testing radiators and tires. The radiators, for instance, when undergoing test, are connected with an air receiver and submerged in the tank, and escaping air shows instantly wherever there is a leak. The leaks are mended by means of a gas torch. Out in the yard of the shop facilities are installed for cleaning machinery parts by distillate sprayed on under a compressed air impulse. A trough is at hand for catching the grease and dirt. Large pieces of machinery are handled by a swinging crane.

The City of Oakland operates a garage and, in connection with it, a shop where are repaired all of the automobiles used by the different municipal departments.

The machine shop is equipped with an air compressor, driven by a small electric motor, which delivers air at a pressure of 150 pounds. This air is piped through the machine shop as well as the garage, and is used for filling tires and for spraying distillate in cleaning engine parts.

The City of San Francisco also owns and operates a machine shop for the purpose of manufacturing and repairing the alarm boxes of the Fire Department. In this shop there has been installed a compressor for furnishing air to the tempering and annealing furnace. A gas blower also utilizes air, at four pounds pressure, for heating and soldering. This air is obtained by tapping the furnace line.

Fine Progress Made on the May Town Tunnel Under Trying Conditions

By M. P. SMITH

Portable compressor, Type 14, operating "Jackhamers" engaged in drilling holes fifteen feet deep.

THE MAY Town Tunnel is on the Guest River Extension of the Interstate Railroad, about nine miles east of Norton, Va. The road is a new one, is eighteen miles long, and links Norton with Bangor, Va., where a connection is made with the Carolina, Clinchfield & Ohio Railway.

The tunnel has a total length of 550 feet; and 330 feet is timber lined. The 220 feet remaining is not timbered because the rock through which it is carried is sufficiently strong to stand unsupported. Upon completion of the excavation, the intention is to line the tunnel with 24 inches of concrete. In its finished form, the tunnel will be 17 ft. by 23 ft. 10 in. high. The height from sub-grade to the spring line of the arch will be 15 ft. 4½ in.

The tunnel was driven from the south end because all of the excavated material was needed near-by for the construction of an embankment. The material first encountered was soft sandstone, slate, and fire clay. The latter was just above the roof grade. This necessitated driving two small drifts at the wall-plate grade, a distance of 60 feet into the hill. At this point they were cut together with a circular drift. Wall plates and ring timbers were put in position, and the work was carried backward toward the portal—being advanced only enough at a time to allow another set of ring timbers to be placed. After the portal was reached and the timber arch completed, the core was removed all the way rearward to the end of the timber.

This same method was used for the next 30 feet of tunnel, after which it was abandoned. In its stead a box heading was driven in the center and advanced fifteen feet progressively. Temporary props were erected in this heading and the side walls were removed for wall plates. Then enough ground was cleared away for the placing of ring timbers. This latter procedure was continued until hard rock was encountered, when timbering was abandoned.

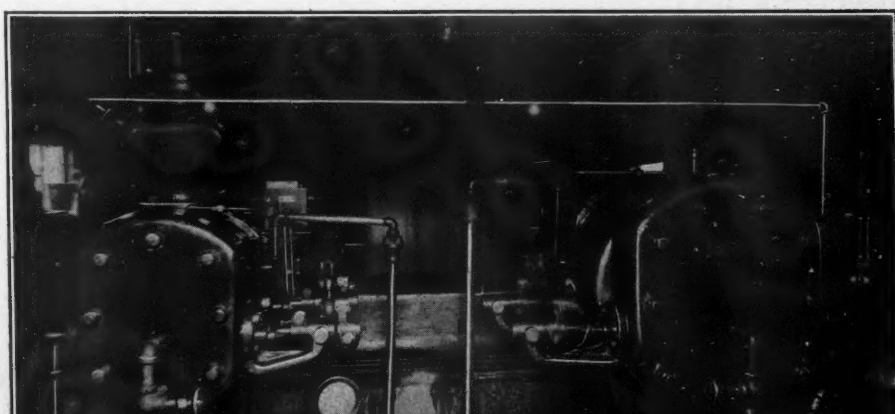
In the hard-rock section, a box heading was pushed forward, and for this work four "Jackhamer" drills, mounted on columns and arms, were employed. The heading was drilled with a V-cut, using fifteen holes to the round. The roof and the sides were carried about ten feet behind the heading so that a large portion of the muck was a goodly distance from the face. This permitted the heading to be mucked out in a very short time, and obviated the handling of the material by the drill gangs.

The heading was started on September 1, 1921, and the end of the timber section was reached on November 23. The entire heading was completed on December 16; but as the North Approach cut was not then made the tunnel was not holed through. The average rate of progress was 4½ feet of timbered section per working day and 10½ feet of untimbered heading per day. The timbering was of the five-segment type, 12 in. by 12 in. yellow pine being used for the wall plates and the ring timbers. The lagging was three-inch pine. Rings or bents were spaced on three-foot centers for the first 60 feet and on six-foot centers for the rest of the way.

The bench was begun on January 12, 1922, after the remainder of the South Approach had been moved. The end of the timbered section was reached on March 18th. The average progress in removing the bench was about six feet daily. The materials encountered were of several grades of blue slate and shale and very dense gray sandstone. Occasionally a coal streak was uncovered, but no vein of any considerable size was met.

"Leyner" sharpeners have speeded up and simplified the work of sharpening the drill steel.

The plant and equipment consisted of one Imperial Type, two-stage air compressor, having a rated capacity of 599 cubic feet per minute at 100 pounds pressure. Power was supplied by a Westinghouse 3-phase, 60-cycle, motor developing 104 horse-power at full load at 870 revolutions a minute. Operating current was obtained from the Old Dominion Power Company by a 2,200-volt, alternating-current line. To reach the site of the work it was necessary to extend an existing power



Ingersoll-Rand two-stage compressor which supplies the compressed air to the rock drills.

Clearing away the west end approach to the adjacent portal of the tunnel.

line about one mile. Lights both for the camp and for the tunnel were energized from the same source.

The compressor is located on a concrete base 1,000 feet from the south portal of the tunnel. This plant has sufficed to provide motive air for the "Jackhamer" drills, for a "Leyner" drill sharpening machine, and for a small pump delivering water to the plant. Air was also furnished for drilling the rock in excavating the North Approach cut. The compressor has worked continuously and without a single breakdown, day and night—Sundays excepted, ever since the job was started.

H. W. Hudson is Chief Engineer of the Interstate Railroad, and the Brooks-Callaway Company of Atlanta, Ga., are the contractors for all grading, masonry, and tunnel work on the line. The writer, representing the contractor, is in direct charge of the excavation of the May Town Tunnel.

"Jackhamer" drilling 15-foot holes in soft sandstone, using Carr bit with holes punched in side of steel instead of hole in face of bit. An average of 150 feet was drilled during a ten-hour shift.

CURIOUS THINGS IN ORDINARY WEATHER CONDITIONS

By FRANK RICHARDS

IT PROBABLY would not be far from the truth to say that we talk more and know less about the weather and weather conditions than about anything else that engages our attention. We all love fair weather and dislike rains and storms. We know in a general way that clouds are all potential rain distributors. A cloud we consider a kind of sponge which comes from somewhere; and when it is squeezed or manipulated in some way the rain drops out of it; and when the clouds are driven away the rain stops.

Now all this is much more wrong than right. The clouds, generally speaking, are not brought from afar but are made on the spot, and when the skies clear again it is not by the blowing away of the clouds but by their going out of existence where they are. This latter phenomenon anyone may observe who has a little time and patience. We frequently have days which are very cloudy in the morning but which turn out clear and sunny after all. When the clearing up is partially accomplished, say early in the forenoon, the sky will be more or less covered by light, scattery clouds with much clear blue sky already uncovered among them. If some isolated bit of cloud or any prominent portion be carefully watched, it will be seen to be constantly changing in shape and density and to be getting thinner and thinner and, before you can realize it, it will have disappeared entirely. This would be an interesting thing for the movies to show except that it is so difficult to get good cloud photographs.

It is not possible to observe or to get pictures of the formation of rain clouds in our actual presence in the same way, for the reason that their beginning is not announced—they are in sight before we know it, and that the operation goes on all over the visible sky at once. In the case of a thunderstorm, this cloud making goes on very rapidly, and everybody has seen it; but still the general impression is that the cloud is brought by the wind, and we seldom think far enough to inquire where it is brought from.

It is our habit to believe that the supreme function of the air is as "the breath of life" to furnish oxygen for all warm-blooded animal creation; but another of its everlasting jobs, and surely a bigger one, is the carrying and distributing of water all over the earth. Every powerful water-wheel is, in the last analysis, a windmill. The distribution of the water is chiefly by means of clouds and rain, and, as a consequence, the atmosphere always carries its load of water for their production. There is no such thing as dry air. It is only drier at times than other air under other conditions.

It is worth while to try to get an idea of the quantity of water present in the air, selecting our conditions for the special inquiry. We will assume a mass of 1,000 cubic feet of free and so-called "dry" air. This quantity would be equal to the entire content of a room four yards square and seven feet high. We suppose this air to be at the comfortable temperature of 65 degrees Fahrenheit. It is ordinary, every-day air, such as that of which the daily papers report the humidity, which is constantly changing, and from which reported humidity several things may be predicated.

At a temperature of 65 degrees, which particular is of importance, 1,000 cubic feet of air in a saturated condition, or with a humidity percentage of 100, would contain one pound, avoirdupois, of water, and if the humidity were down to 50 per cent. and not a cloud in sight, it would contain one-half pound of water.

Now let us see "where we are at." A column of air one foot square at the base and one mile high would contain more than 5,000 cubic feet, and, assuming a humidity of only 50 per cent., the water content would be $\frac{1}{2}x5=2\frac{1}{2}$ pounds, the weight of water in the air above each square foot of surface. If we extended the column to a height of five miles, the weight of water in the air, on the same assumption, would be 12½ pounds. The weight of water above one square mile of surface would be 348,480,000 pounds; and for the entire area of Greater New York, 318 square miles, it would be 110,816,640,000 pounds or, say, 14,775,552,000 gallons. If all this water could be precipitated at once it would cover the ground to a depth of 2.4 inches.

LEATHER MUCH AFFECTED BY MOISTURE

THE STRENGTH and elasticity of leather are greater when the air is moist than when it is dry, and for this reason, says the Bureau of Chemistry, it is important in making comparative tests of leather to be sure that all pieces tested are under the same humidity conditions. A good piece of leather tested in a dry atmosphere might appear to be weaker than a much poorer piece tested when the air was moist. Tests made of more than 500 pieces taken from the most uniform part of the hide, alternate strips being subjected to dry air and damp air at a temperature of 70° F., showed that an increase from 35 per cent. relative humidity to 55 per cent. increased the strength of the leather 13 per cent. and the stretch 16 per cent. When the humidity was raised from 35 per cent. to 75 per cent. the average increase in strength was 42 per cent. and in stretch 53 per cent.

It is apparent that control of the humidity in a room where leather is tested is necessary if the results are to be worth anything. The Bureau of Chemistry has devised such a room in which the amount of moisture in the air may be kept uniform and at any percentage of saturation continuously. It is the only testing room in the world where the conditions are controlled so well.

Mechanical agencies are supplanting low-priced labor in the Orient. Small Chinese firms have found it cheaper and more efficient to hire a truck than to employ the necessary number of coolies to do the same work. A Shanghai newspaper has estimated that the expense of operating one truck for a day is about $31. To do the same amount of work 60 coolies would be required at a cost of from $36 to $48 for labor alone, while other incidental outlays would add to the total.

Compressed Air in the Cotton-Testing Laboratory

By S. R. WINTERS

COMPRESSED AIR, with its ever-widening field of usefulness, is now applied in determining the spinning value of cotton. Uniformity of atmospheric conditions is a prerequisite in a cotton-testing laboratory, and, therefore, air vaporizers are employed to bring about the right degree of humidity.

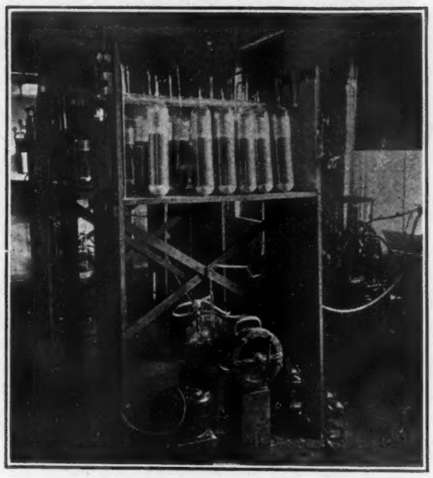
The Bureau of Markets and Crop Estimates of the United States Department of Agriculture maintains a laboratory where the spinning value of different grades and varieties of cotton is subject to exhaustive investigation.

Here, under the competent supervision of W. R. Meadows, the quality of a national crop, representing an investment of billions of dollars, is tested for its bleaching and dyeing properties; for the breaking strength of the yarn and cloth; and for possible wastage in manufacture. This work on the part of our Government should be of interest to all of us owing to the widespread use of cotton.

The laboratory, which is in Washington, is equipped with an automatic humidity and temperature regulator, which keeps the humidity at 65 per cent and the temperature at 70 degrees Fahrenheit. Otherwise the moisture content of the fiber and the cotton products being scrutinized there would vary and thus make it impossible to arrive at definite figures. For the sake of accuracy, a self-recording hygrometer indicates the state of the atmosphere both day and night, and this instrument, in turn, is checked up at periodical intervals throughout the working hours by a sling psychrometer.

Under these uniform atmospheric conditions, brought about by compressed air and the humidity and temperature regulator, the strength of the yarn is determined in the following manner: Twenty-four skeins, each of 120 yards, are wound from different bobbins of the same lot of yarn, and these are placed on a rack located in the center of the room. The fleecy staple remains on the rack over night, and is broken in rotation the following day or, in other words, the skeins are broken successively until the entire lot has thus been tested nearly simultaneously and under identical atmospheric conditions. Each skein may be broken either on a combination yarn-and-cloth testing machine or on a yarn tester, which registers the strength of the specimen in pounds. The broken skein is next placed on a torsion balance or on a direct yarn-numbering quadrant, and the weight or size of the sample is thus determined and made a matter of record. The results of the 24 breaking tests and the corresponding number of sizings of a given lot are then averaged, and this furnishes the textile value of the yarn.

As a means of offsetting slight variations in the weight or the size of a sample taken from different lots or consignments of bleached or dyed yarn, the average strength is corrected in proportion as the average number varies from the desired number. In testing by this method the yarn is reeled from an umbrella reel instead of from bobbins. The yarn may also have its strength determined by a single-strand testing machine. The latter apparatus registers in ounces the strength of a single strand. This procedure is primarily employed in ascertaining the comparative breaking points of gray, bleached, or dyed yarn.



Mechanical equipment used in the evacuation of glass tubes, in which are preserved duplicates of original official cotton standards of the United States.

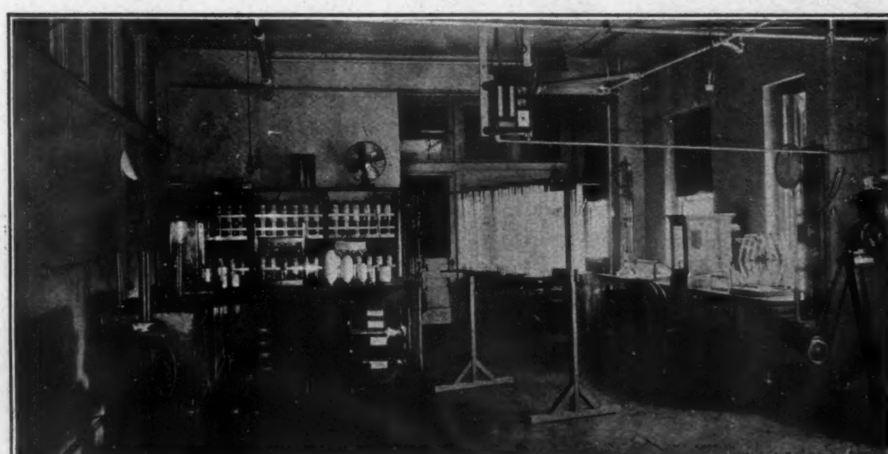
Other comparisons, however, may be made. For instance, a single-fiber, strength-testing machine is sometimes used to measure the average strength of individual fibers assembled from raw cotton and from different apparatus involved in the manufacturing processes. A moisture-testing oven serves the purpose of revealing the moisture content of cotton in the bale and at different stages during fabrication. This is a matter of importance, since the potential waste and the quality of the yarn are primarily dependent upon this factor. An equal-arm balance meets the demand for a miscellaneous weighing unit; while a glass cage is employed for mounting fibers for projection purposes and for microscopic observation.

The Bureau of Markets and Crop Estimates has exercised foresight in providing for the preservation of duplicates of the original official cotton standards of the United States. Every sample has been rolled in pure white paper, reinforced by a sheet of black paper, and enclosed in a glass tube, plugged at each end first with a wad of cotton, next with loose asbestos, and then with a compact wad of the latter material. Subsequently, an expert glass blower closed each tube at one end and drew the other terminal down to a small aperture. The tubes were mounted on racks so that an exhaust pump could be connected with a row of these containers and a vacuum of two millimeters obtained. The tubes were afterwards sealed. Thus, safeguarded from the action of light and the effects of oxidation, the samples serve as standards in gaging variations which may occur from season to season in the quality of the fibre obtained from different parts of the country or from foreign sources.

DUST CARRIED OVERSEAS

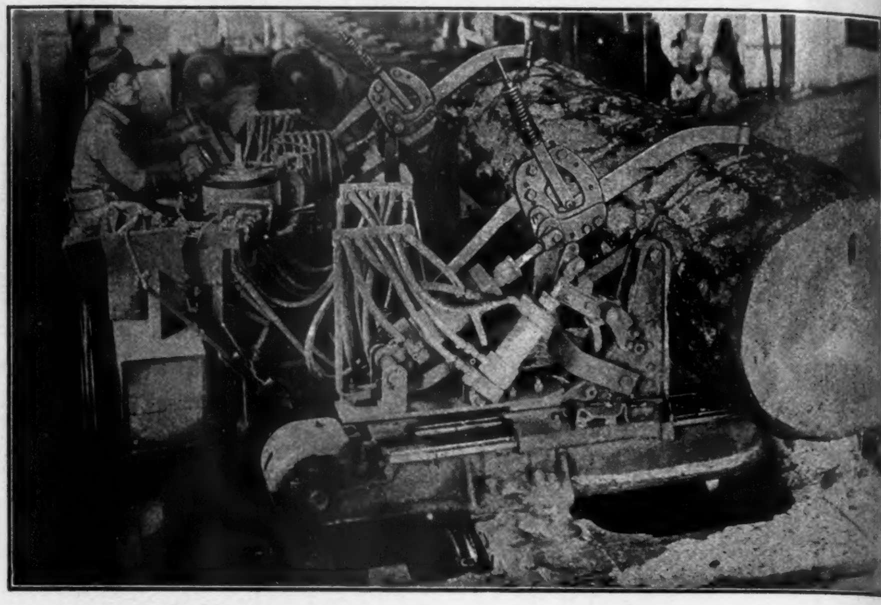
A sample of the dust that settled thickly on the decks of the Dutch steamship *Yildum* in the Atlantic 250 miles from land, latitude 14-15 deg. N., longitude 22-21 deg. W., was recently sent to the Weather Bureau, United States Department of Agriculture, by the captain of the vessel. The dust was undoubtedly blown from the Desert of Sahara. Two days later the British steamship *Dundrennan,* and the Dutch steamship *Hagno,* more than 1,500 miles west of the *Yildum,* observed the same phenomenon, although the amount of dust was much smaller. The Weather Bureau receives regular marine weather reports from ships of twenty nationalities which coöperate with the bureau in collecting and disseminating information about weather conditions at sea.

The "Safety Fourth" idea is now rampant in Mexico, and, for that reason, there is a likely field there for American manufacturers of fireworks. On no fewer than seven different national holidays pyrotechnic displays formed an important part of the celebrations.



A section of the cotton-testing laboratory in the U. S. Department of Agriculture. The work done here is of great service to the cotton textile industry.

A PNEUMATIC DOG FOR THE SAWMILL



The numerous flexible connections show in how many ways compressed air contributes to the success of the Martin air dog.

FOR NEARLY 60 years lumbermen have wished for a device that could be counted upon to hold a log positively upon the sawmill carriage. What they wanted was an equipment that would be safe and likewise quick in action; that would insure a fit of the cant to the knee and provide means for tapering logs properly; and, that, withal, would avoid the dangers and uncertainties incident to long prevailing practice. Any practical millman will unhesitatingly declare this to be a large order to fill, and yet it is claimed that the air dog developed by F. E. Martin possesses all of these virtues.

We need not point out the shortcomings of the usual facilities in order to emphasize the advantages of the air dog. Instead, let us confine ourselves mainly to telling how the new device functions. Each dog is actuated by compressed air which is, in turn, controlled by a valve, and this valve, with certain other associate valves and the operating mechanism, constitutes the unit control. The apparatus is brought into play by the workman's foot; and there is simultaneous action of all of the prearranged functions.

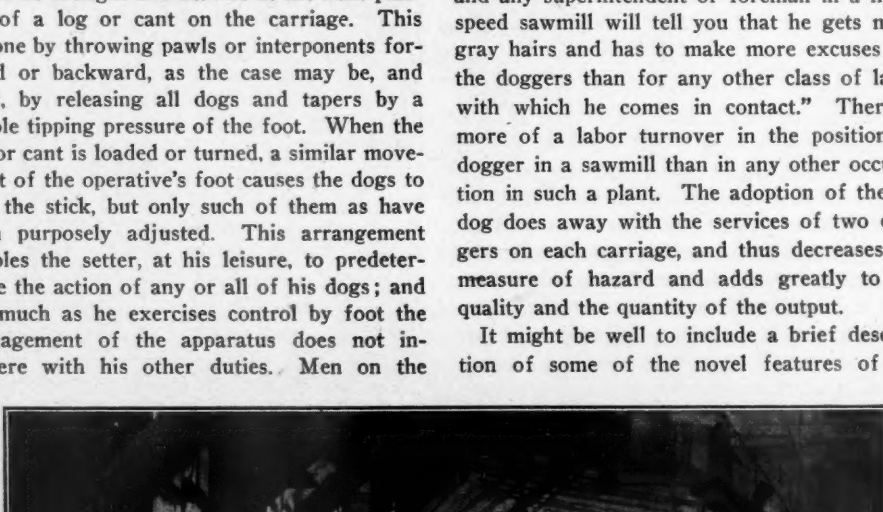
Perhaps we can make this clearer by saying that prior to the time of turning or loading a log on the carriage, the setter decides just which of the dogs and other allied devices are to be brought into service at the next placing of a log or cant on the carriage. This is done by throwing pawls or interponents forward or backward, as the case may be, and next, by releasing all dogs and tapers by a simple tipping pressure of the foot. When the log or cant is loaded or turned, a similar movement of the operative's foot causes the dogs to bite the stick, but only such of them as have been purposely adjusted. This arrangement enables the setter, at his leisure, to predetermine the action of any or all of his dogs; and inasmuch as he exercises control by foot the management of the apparatus does not interfere with his other duties. Men on the job declare that it is less trouble to work the air dog than it is to watch the usual doggers.

As one millman expresses it: "In carriage accidents, the dogger is almost always the victim—the setter seldom suffers. By the very nature of his work the really good dogger is a rarity and of a decidedly transient habit; and any superintendent or foreman in a high-speed sawmill will tell you that he gets more gray hairs and has to make more excuses for the doggers than for any other class of labor with which he comes in contact." There is more of a labor turnover in the position of dogger in a sawmill than in any other occupation in such a plant. The adoption of the air dog does away with the services of two doggers on each carriage, and thus decreases the measure of hazard and adds greatly to the quality and the quantity of the output.

It might be well to include a brief description of some of the novel features of the Martin device, in which compressed air is the motive medium. The dogs or tapers are designed to lock automatically so as to make accidental operation impossible. Opposite the unit control, and placed within convenient reach of the setter's foot, is another pedal, which, like the unit control pedal, serves as a brace for the operator's body. By tipping this pedal, the setter directs streams of compressed air over the faces of the blocks while the log or cant is being adjusted. The air blows the blocks free of waste material and this facilitates the perfect aligning of the cant with the saw line—thus avoiding thin-edged and wedge-shaped lumber.

There is a chain dog which engages the bottom of a log and effectually prevents shifting. It consists of a chain skid, which is raised to engage the log by means of an air cylinder that is also manipulated by the unit control. The chain is fitted with links or spuds which grip the log. Further, the outfit is equipped with a so-called partial-stroke boss dog. This device handles the usual boss dog, and is provided with an air cylinder which has both a full and a partial stroke. For instance, when a round log is presented to the knee, the dog teeth protrude to their maximum limit and penetrate through the bark and into the log. When a sawn face is presented to the knee, however, the penetration of the teeth is so slight that the marks are almost obliterated when the face of the lumber is cut down or dressed only a quarter of an inch. It is impossible to obtain this result in hand dogging.

It seems that more skill is required in tapering logs properly with the familiar rack-and-pinion equipment than is commonly imagined. The work requires strenuous effort, involves risk of injury, and the average dogger will resort to every artifice to avoid the labor and the peril. With the air dog, on the other hand, the taper is operated by power; is well-nigh automatic in its action; imposes no fatiguing work upon the setter; and calls for but trifling attention. Finally, a big lumber concern in



Photos, Courtesy Weed Lumber Co.

A close-up of some of the distinctive features of the air dog. Note the two operating pneumatic cylinders.

California, which employs air-dog installations, makes the following statement regarding the economies effected by the adoption of the pneumatic device:

SAVINGS PER DAY

2 Doggers at $3.40 each	$6.80
Estimated gain in quality of 100 backing boards, 200 dog boards, and boards cut during the canting operation, together with less mutilation by the dogging operation as compared with hand dogging, amounts to at least 500 feet, at $30 per 1,000	15.00
Speed of sawing operation increased the cut by actual performance 5,000 feet per day, at $2.50 per 1,000	12.50
Total gross saving	$34.30

From the foregoing figure should be deducted $1.00 a day to cover increased pay of setter, and an estimated cost of $1.00 daily for additional millwright and up-keep expenses—bringing the net economies to $32.30 per diem. If, as claimed, the use of the air dog can effect this reduction in operating costs, the pneumatic apparatus is certainly a notable step forward in sawmill practice.

SAND BLAST FOR CLEANING BOILER TUBES

LIKE THE POOR, the problem of dirty boiler tubes is always with us. As we know, inventive cunning has devised various agencies by which scale or soot can be removed from these tubes, but probably none is simpler than that which the Germans have evolved latterly.

A machine-building plant at Durlach is turning out a tool which does the trick by an air-impelled sand blast, and this is said to answer admirably in dealing not only with stationary boilers of both cylindrical and water-tube types but with steam generators on shipboard. The appliance is composed of a length of pipe, termed a lance, equipped with a special nozzle, and linked with a compressed-air line and a supply of sand.

The sand cuts away scale and polishes the surface of the boiler tubes the while, without causing damage of any sort. The equipment may be employed effectively in any boiler which is provided with openings which will permit the introduction of such lances. Operable air is required at a pressure ranging from fifteen to about 30 pounds; and the consumption is at the rate of approximately 4,000 feet of free air a minute. In the course of 60 seconds the sand blast will clear away between 40 to 60 square feet of scale. Naturally, the apparatus will show still better results when contending with the far-less resistant soot.

It is claimed by the advocates of this adaptation of sand blasting that these lances do their work not only fast and economically but that they are equally efficacious when attacking either the interior or the exterior fouled surfaces of boiler tubes.

Most people imagine that the bulk of the asphalt used here is produced from Mexican asphalt utilized in various ways in the United States comes from Trinidad. The fact is quite to the contrary. Governmental statistics reveal that substantially 53 per cent. of all the petroleum as a by-product.

COMPRESSED AIR FOR PIPE, TUNNEL, AND TRENCH WORK

SAVING TIME, labor, and expense, means more now than ever. Every successful contractor is fully alive to these facts, and he is aware that this is especially true where the convenience of the public or the speeding up of an industrial undertaking demands the rapid execution of construction and kindred tasks.

Work that used to be done by pick and shovel must now be pushed through with the aid of power-driven machines capable of easy manual control or application. Fortunately, tools of this sort have been developed which make it practicable to reduce to a minimum the dependence upon hand labor. Not only that, but it is now possible to do the work better, even while doing it faster, by reason of the wider application of compressed air—the tireless energy that can be brought into action anywhere.

There are now available portable or semi-portable air compressors which can be moved about at will to furnish the motive impulse for special pneumatic tools admirably adapted to the speedy digging of trenches and tunnels, to the calking of pipes, to backfill-tamping, and to a wide variety of allied operations. A profusely illustrated booklet, entitled Trench, Tunnel, and Pipe Work By Compressed Air, containing much valuable information, has recently been issued by the Ingersoll-Rand Company, and is available to those who may be interested.

Pneumatic calking hammers operated from portable air compressors are proving an effective means of hastening the work and reducing the cost of calking the joints in this 43-inch gas main.

Compressed Air Magazine

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EDITORIALS

AUTOMATIC CONTROL APPARATUS TO IMPROVE RAILWAY OPERATION

THE ADVENT of the air brake was a long step forward towards safety in railroading. Its betterment since has done much to promote the efficient handling of speedier and heavier trains. The introduction of the block-signal system and especially the development of automatic wayside signals have, in their turn, contributed greatly both to celerity of traffic and to comparative security against collisions. However, these two agencies now and then fail to perform their intended services, not usually because of any faulty functioning on their part but by reason of that uncertain factor, the human equation.

Now comes the Interstate Commerce Commission with an edict that has for its purpose the minimizing of the human fallibility of the man or men in the locomotive cab. In short, the commission has ordered 49 of the nation's largest railroads to equip their lines with all practicable dispatch with acceptable forms of automatic train-control apparatus. This whole subject has been under advisement for more than a decade; and inventive minds by the score have devised as many different means wherewith to deal with the problem. Out of this imaginative ruck has emerged a number of systems which have met service tests; and the railways have been given until the first of next January to choose the type they will have installed by January of 1925.

In making selections, the railroads will have several things to weigh: safety, *per se*, is not the only element that must be considered. The air-brake is designed to exert restraint upon speed, to slow down a train but not to stop it unless a halt is necessary. Paradoxically, it is to-day first and foremost an aid in keeping traffic underway, because it permits more rapid travel between the points where a more leisurely pace is desired. In other words, the engineer, thanks to the air brake, can always dominate the situation. Therefore, a really acceptable train-control system should be one that still leaves the highly-trained engine driver in command; which warns him of danger; and which supplants him only when for one reason or another he does not obey the cautionary signals.

These desiderata, though exacting, are attainable, as has latterly been shown; and what is of equal interest, the best of the apparatus operate so that they can be counted upon to function with precision no matter what may be the weather conditions. All of these may be interlinked with the wayside block-signal systems, and are by no means as complicated as might be fancied. There are, of course, interrelated elements, but these work upon well-established principles. Finally, the more flexible of the devices can be adjusted to meet the particular traffic needs of any line.

The attitude of the Interstate Commerce Commission is logical, and, incidentally, a tribute to the inventors that have given of their best in mastering a very difficult engineering problem. In the future, no train, despite possible heedlessness on the part of the engineer or his sudden physical collapse, will be able to run past a signal set at "danger."

LORDS AND LORDS IN ENGLAND

IN AMERICA the British Lord is usually looked upon as one who has inherited his title; one who, being only born great, is not to be taken seriously when measured by our standards of achievement. There are, however, Lords and lords in England. In the first class, in influence and social position, are the titled men who have won their spurs through a life of activity and achievement—men who have become real Captains of Industry.

Conspicuous among these is Lord ASHFIELD, the head of the underground, motor bus and allied tramway systems of transportation in London. It was he who took hold of that antique, the London underground, and made it a going concern. It was he who scrapped those rattle-trap motor buses and substituted the modern noiseless bus; one which carries a passenger a considerable distance through the streets of London for a penny—a little less than two cents.

Lord ASHFIELD's business methods are philosophical and educational. Periodically, usually once a year, he sends some of his head men abroad for two or three months. He calls this a vacation of observation. Their minds are thus relieved of the stagnation of routine work and are free to act on broader lines of vision. They may not see or hear of anything that may be directly applied to London transportation, but they get cues of thought which set them thinking, perhaps while on shipboard, and these cues lead to the solution of problems which add to the efficiency of their work at home. It was through one of these vacations of observation that the centralized system of washing buses was substituted for the garage hand-washing system. This effected considerable economy in the maintenance of the buses on the score of cleanliness. A still greater saving was effected by building a central inspection and repair shop, in place of the old garage system.

ASHFIELD is indeed a Lord among men.

A GROWING DEMAND FOR REFRIGERATOR SHIPS

THE REFRIGERATOR ship pure and simple or the craft with more than the ordinary measure of cold-storage capacity is a type that must inevitably appeal to the maritime fraternity as well as to every industry that produces foodstuffs for remote consumption. What the refrigerator car has done in the way of amplifying and diversifying the American dietary the refrigerator ship can do for the world at large. This fact is gaining wider recognition; and in the last few months certain practical demonstrations have revealed the commercial feasibility of distributing even perishable fruits and vegetables over long ocean trade routes.

Last December, a steamer carried from Seattle to New York a big cargo of apples, fish, butter and other refrigerated products which had previously reached the eastern market by rail. California fruit growers have similarly profited by water transportation via the Panama Canal, and the results have been in all respects satisfactory. Indeed, it is the declared intention of fruit growers of the Pacific coast to utilize similar facilities in sending some of their commodities to Europe.

During February and March of the current year the refrigerating compartments of certain passenger steamers plying between Valparaiso and New York were filled, on their northbound voyages, with various fruits and such vegetables as tomatoes and asparagus. The Agricultural Bureau of the Chilean Government is squarely behind this movement to find foreign markets for their farm products, and the outlook is a promising one when it is realized that the warm seasons of Chile occur during the cold months of the northern hemisphere. Argentina is competing with Chile in this business, and sent to New York during the same months consignments of grapes, peaches, plums, and melons. And it is interesting to recall that South Africa has recently begun to ship to our Atlantic seaboard quantities of luscious fruit.

American producers have reciprocal markets open to them when their seasons of plenty come around, and they may dispatch their commodities to Europe, to Africa, and to South America in turn. The magnitude of this inte

ange of foodstuffs will be determined enely by the cold-storage capacities of the ves-s available for the service. We have long cepted refrigerator cars as matters of course, t refrigeration has not generally obtained the me recognition in the realm of water-borne ffic. However, we are authoritatively inrmed that chemical or mechanical refrigeron on steamers is more economical than reigeration by icing as usually practiced upon e majority of railroads.

The expansion of this line of business would evitably prove a boon to many millions of ople the world over.

RADIO IN A NEW ROLE

MOST OF US KNOW something about the difficulties that had to be overcome in aking it possible to adapt first the wireless legraph and then the radio telephone to airane service. Hearing, alone, is not always nvincing, and the old saying about "Seeing believing" still holds good—especially in ficial circles where it is often necessary to ve an order in black and white to place sponsibility where it rightly belongs.

The latest development in the realm of dio is the teletype, which has been devised the navy's wireless wizards. It is the radio unterpart of the telautograph quite common many hotels and industrial establishments. ereafter, the observer aboard a scouting seaane can turn to his teletype and, while keepg the enemy in view, play away on the maine and thus transmit, to either a shore base a flagship, a running account of the dissition and the character of the foe's forces. multaneously, a wireless receiver will transrm the message into text even though no man agency be at the moment on duty or operly alert.

It calls for no great stretch of the imaginan to picture how the teletype may find many laptations, in the diversified phases of modern fe. Once more, an instrument designed priarily for military purposes is likely to prove r more useful in peaceful service.

MODERN HIGHWAYS A NATIONAL PROBLEM

AUTOMOTIVE VEHICLES have outgrown the run of roads available to them roughout the length and breadth of the land. we are to make the most of our trucks for ansportation and of our automobiles for easure and other service it is indispensable at the public be aroused to our fundamental eeds in the matter of highways. Inevitably, a eady increase in volume of freight must be oved by power-driven vehicles not only to ghten the burden upon the railways but to ring outlying districts in touch with the railads and river traffic, and to move commodies quickly from rural districts into populous enters.

Thomas H. MacDonald, Chief of the Buau of Public Roads of the United States epartment of Agriculture, is tireless in his forts to lay the facts before the people in rder that they may have a true conception of e problem which intimately concerns everyone. As this expert points out, "Research in the field of the weight of loads that can be carried by different road surfaces is revealing very definite information. The influence of subgrade soils, of tire equipment, of the distribution of the loads to the wheels, of the speed, and many other variables are too complex to be written into law."

It may shock many to learn that an examination of such progress as has been made in highway building during the past ten or twelve years indicates a very serious lag in the development of the roadbed in comparison with the increase in the rolling stock. As the situation stands, it is likely to take a full decade or more to provide a proper roadbed for the rolling stock now available; and it is a matter of common knowledge how rapidly the manufacturers are turning out automotive vehicles. There is an insistent demand on the part of a very large body of owners that the construction of improved roadbeds be hastened. Satisfaction of this demand would call for exceedingly heavy expenditures.

Our total outlays for all highway purposes in this country last year totaled about $600,000,000. This is the maximum disbursement for any year; but even this rate will not be enough to meet within any reasonable period the call for better roads. To-day, there are in service more than 10,000,000 power-driven vehicles in this country, to say nothing of the large numbers of horse-drawn conveyances in use.

Complex as the whole question undoubtedly is, it should be a matter of gratification that highway engineers and contractors now have at their disposal facilities for the testing of roads which make it possible to answer positively some of the structural questions which have hitherto been so puzzling. Hereafter, instead of groping along until the roadbed collapses, it will be feasible to detect incipient failure before it has reached a dangerous stage and, similarly, to make certain that the roadbed is sound at the start and, therefore, likely to bear up for a goodly period against any of the stresses to which it would be normally subjected.

THE FROZEN FACE

"ONE MAY SMILE, and smile, and be a villain," but, happily, it does not follow that a man is a villain just because his face wears a smile.

Constant contact with large numbers of the public, as at subway gates, the rear of street cars, and at the ticket wickets of railways, theaters and the like, has developed the opposite of the smiling face. It is not necessarily a scowling countenance, but its expression, or lack of expression typifies several emotions among which are suspicion, boredom, supreme contempt for the public to which its employer caters, and disgust for its job.

This stolid, forbidding countenance has been called the "frozen face." It is never safe to address a question to its wearer for the answer it gives back is often curt and uncivil.

We all recognize it. It is often seen behind the teller's wicket at the bank and we sometimes wonder if the printed card so prominently displayed bearing the inscription "SMILE" is meant for us in front or for him behind. We see it at the City Hall where wo go to record our deeds; at the Custom House where we pay our taxes; at the post office where we buy our stamps. It is not a pleasant face to look at. Perhaps the excuse for it, if excuse there be, is found in the irritating effect of having constantly to do with so many men of so many minds.

In this bright, cheerful, livable world of ours there is no room for the "frozen face," nor for the disposition which it reflects. Because your lot has not fallen in pleasant places and is not what you would select if you had your way, remember that you are responsible for its making and not the innocent bystander upon whom you would vent your spleen.

The world doesn't owe you a living. It's "up to you"—and it's "up to you" to do it with good grace.

LONDON FOGS MAY BECOME ONLY A TRADITION

A FEW YEARS AGO tests were made to learn whether or not it would be practicable to dissipate heavy fogs by means of a system of electrical precipitation. Up to a point the scheme was promising, but the researches never got much beyond the laboratory stage. Now come scientists of the Mellon Institute of Pittsburgh with another method of attack which may prove the long sought solution of the problem.

The pouring of oil on troublous waters may be the means of achieving more than merely robbing the waves of their smashing power. Physicists have known for a good while that a blanket of heavy mineral oil laid upon a body of water is capable of effectually arresting evaporation; and this fact is now counted upon to check the evolution of fog. It seems that some of the scientists of the Mellon Institute have discovered, after five years of investigation, how to spread a film of oil only one twenty-fifth as thick as that hitherto produced by certain petroleum products and yet possessing a tenacity quite as great as that of the thicker coating. This newest film has a thickness of only 1/7500th of an inch, so it is reported; but, even so, in the laboratory, it has sufficed to prevent heated water from giving off vapor during a period of 100 days.

A 29-mile stretch of the Monongahela is to be the seat of a full-sized demonstration; and the authorities of the War Department are to collaborate in the experiment. Every fogridden section of the world should be interested in the outcome. Think of what this may mean in the way of lessening the perils of the navigator quite apart from the boon it may prove to dwellers ashore in the neighborhood of large bodies of water.

If the present programme of the Italian State Railway Administration is carried out, the government-operated lines by the end of 1926 will have under electric operation 3,177 miles of road, or 32 per cent. of the total length of the state railway system.

A STUDY OF THE MANUFACTURE, PROPERTIES, AND USES OF CARBON BLACK, made by Roy O. Neal, Consulting Engineer, and G. St. J. Perrott, Physical Organic Chemist, has recently been issued by the U. S. Bureau of Mines in Bulletin No. 192.

FORTY BILLION cubic feet of natural gas are used annually in the United States in the manufacture of carbon black, a material which is employed in the making of an astonishing number of articles of everyday use. Carbon black is utilized extensively in the rubber industry, something like 20,000,000 pounds going each twelvemonth into the production of automobile tires. From 10,000,000 to 12,000,000 pounds of carbon black are used annually in the making of printers ink, and from 4,000,000 to 5,000,000 pounds in the manufacture of stove polish. In normal times the United States exports probably 10,000,000 pounds of carbon black in a year.

SCIENTIFIC SELLING AND ADVERTISING, by Arthur Dunn. 159 pages. Price $3. Published by Harper and Brothers, New York City.

THE PURPOSE of this book is to put selling and advertising on a new scientific basis and to lay the facts of this field of endeavor before the reader so that he can appreciate, when all is said and done, that the whole matter is one of common sense and the psychology of everyday intercourse in the business world.

The author has sold millions of dollars' worth of securities, drilled and educated salesmen, conducted large sales organizations, and made a careful analysis of the steps leading up to the making of a sale. The present volume is literally a salesman's handbook, bridging the span between the buying and the selling world. The necessary points of successful salesmanship are not only set forth lucidly but pains are taken to show those interested just how to master them.

Mr. Dunn takes a shy at that fetish of business intercourse, personal magnetism, and he says, "Let me tell you all about it—let me expose the fake. Magnetism is a mixture of rugged Honesty, pulsating Energy, and self-organized Intelligence. I believe, absolutely, that TRUTH is the strongest and most powerful weapon a man can use, whether he is fighting for reform or fighting for a sale. Truth unconsciously makes one strong and aggressive."

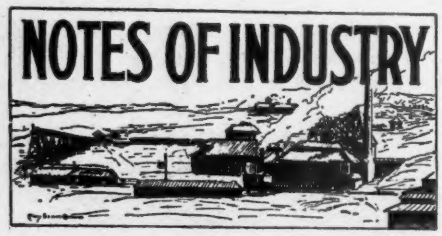
According to the author there are two A's in selling—Aggressive and Agreeable. Be aggressive; be agreeable; combine the two. You must have the interest of your customer at heart. You must know everything possible about the articles or securities which you are selling You must have faith in what you are selling and faith in the man, or firm, or organization for which you are working. You must believe in yourself, believe in your ability to sell.

A ZONING PRIMER, is the title of a publication recently issued by the Division of Building and Housing of the Department of Commerce. Copies can be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at five cents each.

THE ENORMOUS waste in American cities from scrapping good buildings on account of the blighting of districts has long been apparent, and for years has levied its tax on the American people.

The pamphlet describes the object of zoning, the need, the health and property protection afforded, and its effect on the cost of living. Legal problems, with an outline of what some cities have accomplished, and a zoning program are also included among other subjects.

PULP AND PAPER MILL LUBRICATION is the title of the latest of a series of informative pamphlets which has been issued by the Vacuum Oil Company, New York. This booklet is well written and copiously illustrated; and should be a valuable addition to the files of any engineer interested in the particular field of lubrication discussed in the 50-odd pages of text.



John Williams, director of the maintenance department of the Indiana Highway Commission, has recently made a thorough official trial of the use of compressed air for painting bridges, with the determined result that the spraying of the paint is considerably cheaper and quicker than hand brush work.

Enough oil is obtainable in Alberta to supply the world's requirements for over 600 years, according to Thomas S. Howson of Vancouver, an expert in oil production and refining. He referred to the oil contained in the vast fields of bituminous sand in the district of McMurray, on the Athabasca River and on the Slave River.

Upon the authority of *American Silk Journal*, artificial silk is the most perfect fiber known; it is even superior to the thread of the silkworm. It runs more uniform in size, is cleaner, freer from defects, and is without the great variations in color peculiar to the product of the silkworm.

Glazed kid tanning plants in the United States, which are operating at between 50 and 75 per cent. larger capacity than a year ago, attribute the demand for leather to the more general return to the wearing of shoes by women in preference to pumps hitherto in vogue.

A pneumatic caisson of record magni
1,130 by 197 ft., is to be used at Havre, Fr
to form the foundation of a new dry dock
one construction including the entire area.
framing of the caisson will comprise six lo
tudinal trusses 21 feet deep and 40 transv
trusses. The dock will accommodate ve
larger than any now in existence, say of
000 tons displacement, being 1,024 by 174
and allowing a draft of 44½ ft. The we
of the caisson will be about 8,000 tons.

It is likely that experiments will shortly
made in the Philippines in the preparation
hemp waste and low-grade hemp fiber for
ing pulp to be employed in the manufacture
paper. According to Commerce Reports,
purpose of these experiments is to develop
additional use for hemp. In the past, hemp
been worked primarily into cordage, but
demand from that industry is now so limit
relatively speaking, that there is a depression
the business of the hemp growing interests.
is probable that the United States would
the principal market for pulp made from
hemp-waste in question. As a matter of
last year considerable hemp was shipped to
pan for paper-making purposes, and hemp
in varying percentages is needful in the prod
tion of certain sorts of strong paper bags.

It is reported that a bill has been introdu
in the Parliament of the Union Governm
of South Africa providing for the immedi
construction of 22 short railway connectio
aggregating 851 miles of line, which will
volve an expenditure of substantially $20,0
000.

America's total exports of lumber in
shape of boards, planks, and scantlings, for
month of June past, amounted to 152,000
feet as compared with 198,000,000 feet w
was the monthly average for the last pre-
year, 1913. This is considered a very satis
tory showing and one that should be encourag
to American lumber interests. While the
exports of sawn lumber for the fiscal year e
ing in June, 1922, amounted to 1,552,000,000
nearly 300,000,000 feet in excess of the expo
for the corresponding period in 1921, the
clared value of $52,677,000 was $18,000
which probably about represents the gen
fall in lumber prices.

Aviation insurance, covering all classes
travelers in airplanes, is, so the Departme
Commerce announces, procurable in Germa
The yearly rate for factory aviators and
students, on a 1,000-mark policy, is 50 ma
for death. Other aviators, such as sports
teachers, pilots, observers, engineers, and
sengers, also take a 50-mark rate. For indi
ual flights, passengers pay one mark for
tances up to 150 kilometers (93 miles).
rate increases with the distance up to 450
meters (279.5 miles), for which 2.25 mark
payable on a 1,000-mark policy covering
The premium for invalidity is in most
about half that for death.

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